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Dr. A. A. COMMON, LL.D., F.R.S., President, in the Chair.

Andrew Russell Forsyth, Sc.D., F.R.S., Sadlerian Professor of Pure Mathematics, Cambridge ;
John Willoughby Meares, Clive Hall, Shrewsbury ; and
William Willett, Junr., The Cedars, Chislehurst Common, Kent, and 2 Sloane Gardens, S.W.,

were balloted for and duly elected Fellows of the Society.

The following candidates were proposed for election as Fellows of the Society, the names of the proposers from personal knowledge being appended :

Antoine d'Abbadie, Membre de l'Académie des Sciences, 120 Rue du Bac, Paris (proposed by G. H. Darwin) ;
Loyal H. Bradford, of North Ferrisburgh, Vermont, U.S.A. (proposed by Lewis Swift) ; and
Oswald Thomas Tuck, Naval Instructor, School Ship *Conway*, Birkenhead (proposed by E. W. Maunder).

Seventy-six presents were announced as having been received since the last meeting, including, amongst others :—

T. G. Elger, The Moon, presented by the author ; Lund Observatory, Observations de la Zone entre 35° et 40°, presented by the Observatory ; twelve photographs of a globe of *Mars*, prepared from drawings made at the Lowell Observatory, Arizona, presented by Percival Lowell ; eight photographic enlargements of portions of the Moon, from negatives by Lœwy and Puiseux,

presented by Dr. Weinek; photographs of *Orion*, the Milky Way, &c. (negative, lantern slides, and enlargements), presented by Dr. Sheldon; lantern slide from negative of the Cluster in *Hercules*, presented by W. E. Wilson.

Answer to an Inquiry in the "Bulletin Astronomique" for May 1895, *p.* 233. By E. J. Stone, M.A., F.R.S., Radcliffe Observer.

In the *Bulletin Astronomique* for May 1895 there is a short notice of my paper, "On Some Points connected with the Integration of the Differential Equations of the Relative Motions of Material Systems" (which appeared in the *Monthly Notices* for 1894 June), which very clearly and concisely states the fundamental point of my paper to be the unchangeableness of the fundamental constant, f; but adds: "Il serait à désirer que M. Stone formulât d'une manière nette et précise les critiques qu'il sous-entend en parlant de conditions incompatibles entre la variable représentant le temps et les observations."

I have no difficulty in answering this very reasonable request.

If we denote the geocentric co-ordinates of the Sun under the usual forms

$$2\pi\iota + \odot = l + nt + \lambda t^2 \ \&c. + \int A \sin(\alpha t + \beta),$$

$$\frac{1}{r} = \&c.$$

$$\beta = \&c.$$

where $\int$ denotes a definite number of periodical terms, then in the mathematical investigations of the disturbances of the elliptic motions the effects of all the terms in the geocentric co-ordinates of the Sun, including those which are themselves due to planetary and lunar disturbance, are duly investigated subject to the condition

$$\delta[n(t+\tau)] = 0,$$

or, with *exact* values of t and a definite epoch,

$$\delta n(t+\tau) = 0,$$

and included in the different theoretical expressions of the geocentric co-ordinates of the Moon and planets.

If any long inequality,

$$P \cdot \sin(pt+q),$$

has been omitted in the expressions for $\odot$, $\frac{1}{r}$, and β, the theoretical determination of the disturbing effects cannot be regarded as complete until those due to this term have been investigated, and, if found sensible, included in the theoretical expressions of the Moon and planets.

The resulting theoretical expressions for the geocentric coordinates of the Moon and of the planets can thus be made complete; but they will only be exact when the conditions under which they have been mathematically investigated are fulfilled; and the condition $\delta n\ (t+\tau)$ requires that the variable t, with which the theoretical expressions are compared with observation, should satisfy the condition

$$(1)\quad 2\pi\iota + \odot = n\tau + nt + \lambda t^2 + \mathrm{P}\,.\,\sin\,(pt+q) + \int \mathrm{A}\,\sin\,(\alpha t+\beta)$$

with the value of n, which is used to fix the numerical value of f, or to eliminate that symbol from the mathematical formulæ, and the value of $\tau = \frac{l}{n}$ which has been used to render definite the instant from which t is measured.

But if the theoretical expressions of the geocentric coordinates of the centres of gravity are expressed as functions of the variable t, which satisfies the equation (1) with assigned values of l and n, we must express the right ascensions of the meridians as functions of the same variable; and if α is the right ascension of an observer's meridian, we shall have

$$(2)\quad 2\pi\iota + \alpha = \mathrm{A} + \Omega t + \sigma t^2 + \mathrm{N}ut.$$

where A and Ω are constants which cannot be found except from a discussion of observations. The values of A and Ω, which will for a definite meridian correspond to assigned values l and n in the equation (1), can only be approximately assigned at the present time. But they will be expressible under the forms

$$\mathrm{A} = l + \delta l. \qquad \Omega = \left(\frac{2\pi}{\mathrm{N}o} + 1\right) n,$$

where δl and $\mathrm{N}o$ are unknown quantities, to be found from the discussion of observations; and we can, if we please, put

$$\mathrm{N}o = \frac{n+\delta n}{365{\cdot}25}.$$

We have then to find the quantities δl and δn from a discussion of the observations.

But if we neglect the terms δl and δn in the equations

$$(3)\quad 2\pi\iota + \alpha = l + \delta l + \left(\frac{2\pi \times 365{\cdot}25}{n+\delta n} + 1\right) nt + \sigma t^2 + \mathrm{N}ut.$$

in comparing the results of theory with observations, either directly or in finding the value of the variable from the observed right ascensions, we, at once, by the neglect of the terms δl and δn, introduce between the facts of observation, α, and the variable t, employed in the theoretical investigations, impossible conditions; and these are the incompatible conditions between the variable representing the time and the observations to which I refer.

Micrometer Measurements of Phobos, the Inner Satellite of Mars, during the Opposition of 1894. By H. F. Newall, M.A.

The following measurements of the inner satellite of *Mars* were made during the opposition of 1894 with a filar micrometer on the 25-inch refractor of the Cambridge Observatory.

The satellite could on most occasions be seen with the planet in full sight in the field, but it was found to be easier to make the measurements when the main glare of the planet was subdued by a slip of mica, tolerably thickly blackened by smoke, fixed to the eyepiece in such a way that the mica was as close to the plane of the webs as possible consistently with safety to the webs. No illumination of the field or webs was used, the satellite being so close to the planet that there was enough light in the background to make the webs visible.

There are in the micrometer two frames, A and B, each carrying a set of webs, one moved by a screw A, the other by screw B. The measurements of distance were all made with the screw B. The value of one revolution has been taken as $5''{\cdot}911$*, determined from measurements of the separation (about $270''$) of two stars in the *Pleiades*, a provisional value of the separation being taken from Elkin's measurements.

The only webs on frame A with which we have here to do are two parallel webs, A_3 and A_5, separated by a fixed interval of about $8''$, and a fixed web, FF, which is parallel to the axes of the screws A and B, and perpendicular to A_3 and A_5. The middle point of the part of FF between A_3 and A_5 is moved by movements of the screw A and of the micrometer box on its slipping piece so as to be at the centre of the position circle. When this adjustment was completed, neither screw A nor the

* This value may require a slight alteration; it will be given when the sources of some curious discrepancies which have occurred between the results of determinations by different methods are more thoroughly understood. I am indebted to Professor Turner for his kindness in measuring a large number of photographs of the Pleiade with a view of giving a reliable value for the separation of the stars I used in one of my methods.

slipping piece was moved during the measurements. *Mars* was brought by moving the telescope into such position that equal segments were cut off by A_3 and A_5, and that FF bisected the disc ; the slow motion in R.A. is actuated electrically.

The position circle is turned till FF also passes through the satellite, and B is moved up to bisect the satellite.

The procedure finally adopted was—

(i) To centre the planet on FF and A_3A_5.
(ii) To turn FF to bisect the satellite, or rather to put FF a little ahead of the satellite in its apparent orbit.
(iii) To move up B to bisect the satellite when it reached FF.
(iv) To begin counting with the chronometer when the double bisection was satisfactory.
(v) To look back to the planet to verify the centering.
(vi) To read the chronometer, if centering and bisection were both satisfactory.
(vii) To read the micrometer and position circle at leisure, or to start again afresh if the requirements were not satisfied.

It was decided to adopt this somewhat troublesome method of procedure rather than to make use of the convenient slipping piece and take several readings of distance and position angles separately, because the first attempts to make measurements showed how rapid the motion of the satellite was, and it seemed best to concentrate effort and care on a single set of simultaneous values of position angle, distance, and epoch.

It will be seen that there are fifty-four observations recorded, sixteen referring to western elongations on three nights, the remaining thirty-eight referring to eastern elongations on three nights.

A correction for phase was applied, based on the assumption that the measurements referred to the centre of gravity of the illuminated disc of *Mars* :

$$\Delta s = \frac{4a}{3\pi} \sin^2 \frac{E}{2} \cos (p - Q),$$

where a (apparent diameter), E (areocentric angle between Earth and Sun), p (position angle), and Q (position angle of greatest defect in illumination) had values assigned by interpolation from Marth's valuable ephemerides (*Monthly Notices*, vol. liv. pp. 394 and 557). The interval between the fixed wires A_3 and A_5 was small enough compared with the apparent diameter to make it probable that the "centre of gravity" correction would be nearer the mark than a correction based on the idea that the observed centre was midway between the terminator and the limb.

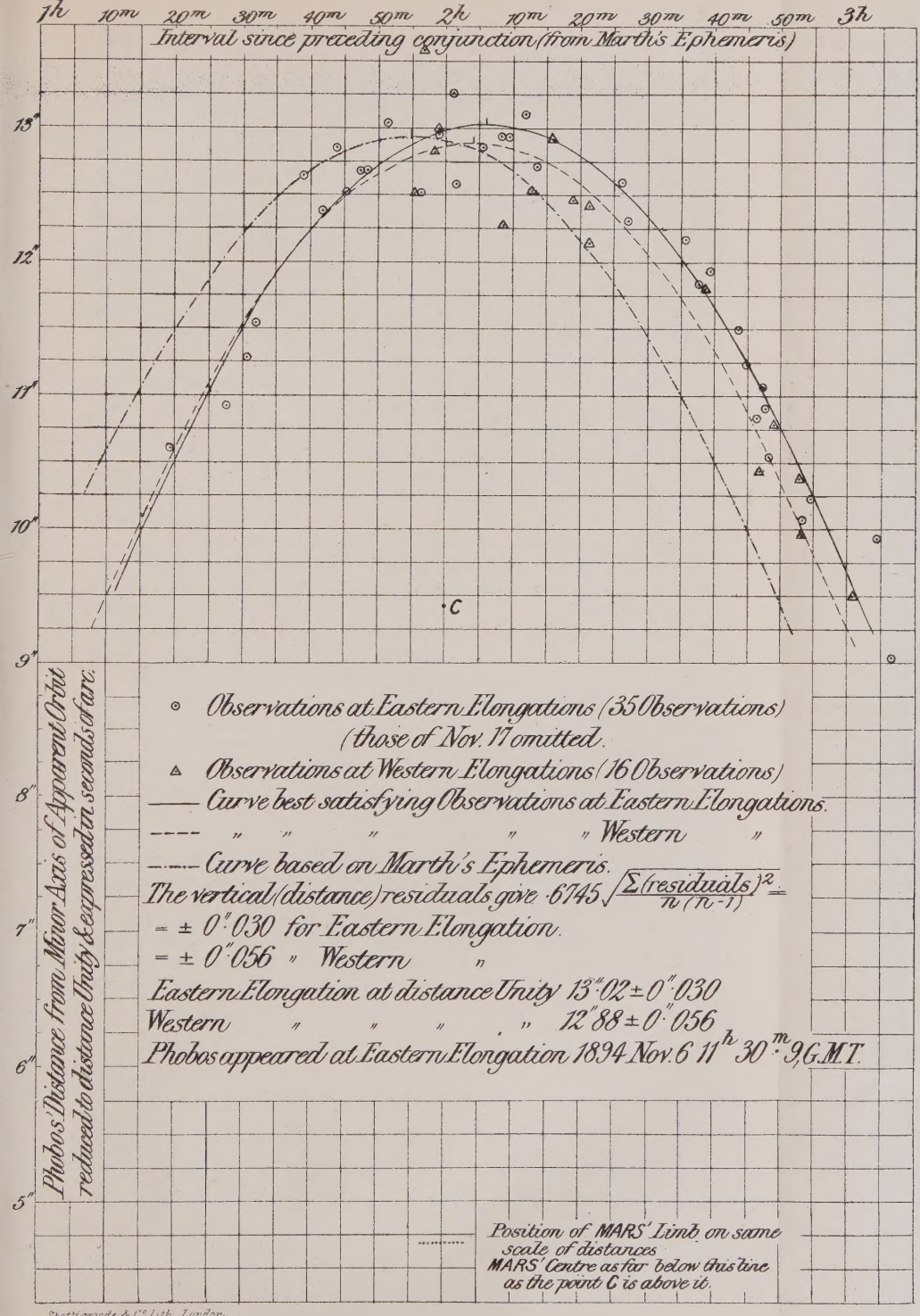
The phase correction was not applied to the position angle, such correction seldom amounting to $0^\circ{\cdot}01$. Nor was any correction for refraction made.

I am indebted to my assistant, A. W. Goatcher, for efficient help rendered during these observations.

1894.	Greenwich Mean Time. h m	Observed Distance. "	Correction for Phase. "	Corrected Distance. "	Distance at Distance Unity. "	Position Angle. °	
Oct. 19	11 1·39	31·25	...	...	13·59	...	
	16·36	28 82	...	...	12·54	...	
	23·33	28·66	...	...	12·47	...	
	25·55	28·53	...	...	12·41	...	Observations interrupted by cloud.
	46 27	...	...	...	...	228·33	Mean of two obns. 228·63, 228·03.
	53·25	24·93	...	...	10·85	...	
	57·24	24·02	...	...	10·47	...	Observations stopped by cloud.
Oct. 26	11 20 31	27·97	...	...	12·51	...	
	22·81	28·68	...	...	12·82	233 48	
	32·78	27·49	...	...	12·29	231·98	
	12 2 69	26 84	...	...	12·00	224·57	
Nov. 6	10 44·66	22·98	−0·13	22·84	11·02	...	
	52·64	23·57	−0·13	23·44	11·31	...	
	55·63	24·35	0·13	24·21	11 69	...	
	57·62	24·93	0·13	24·79	11·97	...	
	...	...	...	...	...	64·55	
	11 3·61	26·59	0·13	26 46	12·77	...	
	10·09	26·35	0·13	26·22	12·65	...	
	12·59	26·69	0·13	26·56	12·82	...	
	13 59	26·69	0·13	26·55	12·82	...	

1894.	Greenwich Mean Time. h m	Observed Distance.	Correction for Phase.	Corrected Distance.	Distance at Distance Unity.	Position Angle.	
		″	″	″	″	°	
Nov. 6	11 21·56	26·36	0·13	26·23	12·66	...	
	26·55	26·55	0·13	26·41	12·75	...	
	29·56	...	...	...	...	54·33	
	33·53	26·90	0·13	26·77	12·92	...	
	38·02	26·48	0·13	26·35	12·72	...	Observations interrupted by cloud.
	48·49	...	...	...	...	48·69	
	50·98	26·38	0·13	26·25	12·67	...	
	52·48	25·83	0·13	25·69	12·40	...	
	59·46	25·55	0·13	25·42	12·27	...	
	12 2·35	24·86	0·13	24·72	11·94	...	
	4·34	25·02	0·13	24·89	12·02	...	
	5·44	...	...	...	...	40·10	
	8·40	24·87	0·13	24·75	11·95	...	
	9·40	24·31	0·13	24·18	11·67	...	
	11·40	23·45	0·13	23·32	11·26	...	
	12·40	23·59	0·13	23·46	11·33	...	
	13·40	22·79	0·13	22·67	10·94	...	
	19·40	22·16	0·13	22·03	10·64	...	
	29·38	21·45	0·13	21·32	10·30	...	Observations stopped by clouds.
Nov. 15	9 22·66	24·12	−0·25	23·86	12·53	65·43	

1894.	Greenwich Mean Time. h	m	Observed Distance.	Correction for Phase.	Corrected Distance.	Distance at Distance Unity.	Position Angle.	
			"	"	"	"	°	
Nov. 15	9	25·95	24·81	−0·25	24·57	12·89	60·78	
		33·93	25·11	0·25	24·86	13·05	58·74	
		40·91	24·92	0·25	24·68	12·95	55·68	
		43·90	25·50	0·25	25·25	13·26	57·40	
		47·39	24·71	0·25	24·46	12·84	54·51	
		51·38	24·85	0·25	24·60	12·92	55·41	
		54·57	25·33	0·24	25·09	13·17	51·10	Telescope reversed.
	10	28·88	22·31	0·22	22·09	11·60	39·23	
		35·46	20·43	0·22	20·21	10·62	38 16	
		48·65	18·53	0·22	18·31	9·62	36·29	
Nov. 17	7	16 29	24·08	−0·27	23·80	12·74	63·80	Bad seeing.
		30·26	22·28	0·27	22 01	11·78	59·59	
		40·09	24·03	0·27	23·76	12·15	57·12	Observations stopped by cloud.
Nov. 19	9	19·85	23·41	+0·29	23·71	12·97	236·71	Seeing very variable: often necessary to wait for many minutes.
		36·83	23·34	0·29	23·63	12·93	233·17	
		42·54	22·05	0·28	22·34	12·23	228·88	
	10	8·30	19·60	0·27	19·87	10·88	219·62	
		15·02	18·86	0·26	19·12	10·47	218·15	
		21·92	18·28	0·26	18·53	10·15	215·59	


1h 10m 20m 30m 40m 50m 2h 10m 20m 30m 40m 50m 3h
Interval since preceding conjunction (from Marth's Ephemeris)
13″
12″
11″
10″
9″
8″
7″
6″
5″
C
Phobos' Distance from Minor Axis of Apparent Orbit reduced to distance Unity & expressed in seconds of arc.
⊙ Observations at Eastern Elongations (35 Observations) (those of Nov. 17 omitted.
△ Observations at Western Elongations (16 Observations)
—— Curve best satisfying Observations at Eastern Elongations.
---- " " " " " Western "
-·-·- Curve based on Marth's Ephemeris.
The vertical (distance) residuals give ·6745 √(Σ(residuals)²/n(n-1)) =
= ± 0″·030 for Eastern Elongation.
= ± 0″·056 " Western "
Eastern Elongation at distance Unity 13″·02 ± 0″·030
Western " " " " " 12″·88 ± 0″·056
Phobos appeared at Eastern Elongation 1894 Nov. 6 11h 30m·9 G.M.T.
Position of MARS' Limb, on same scale of distances MARS' Centre as far below this line as the point C is above it.

Spottiswoode & Co. Lith. London.

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A simple graphical method of getting a survey of the observed places suggested itself. The corrected values were reduced to distance unity, and the intervals that had passed since the last conjunction of the satellite with the planet, as deduced from Marth's Ephemeris, were determined. All the observations were thus available for plotting on a single curve. It was decided to deal with distances measured parallel to the major axis of the apparent orbit, and therefore a correcting factor $[\cos\{p \sim (P \pm 90)\}]$ was applied to the reduced distances. If the orbit were circular, the curve obtained by plotting the time and the distance parallel to the major axis would be a curve of sines. It was expected that a suitable sine-curve-template moved about among the plotted observations would reveal discrepancies. It appears that the time devoted would probably have been better spent on the laborious method of least squares. It is, however, perhaps not without interest to show the results of plotting the observations (see Plate 6), for they at any rate bring to light that the adopted periodic time of *Phobos* needs a slight correction, *Phobos* being between nine and eleven minutes later than Marth's Ephemeris.*

It is not improbable that the error in the time of elongation of *Phobos* has been accumulating since one of the oppositions shortly after its discovery. Such a belatedness as nine minutes shows either that we are not entitled to use the three figures after the decimal point in the seconds in the periodic time, or that a change in period has occurred.

It seems almost unjustifiable to compare the results of these scanty observations with those of the splendid set of measurements recently published by W. W. Campbell (*Ast. Journ.* vol. xv. p. 1). There appears in my observations evidence of differences between eastern and western elongation-distances of the same kind as those which Professor Campbell's observations establish; it should, however, be noted that my observations at western elongation were not so numerous or satisfactory as those at eastern elongation. Professor Campbell notes that his observations show that *Phobos* is $6^m \pm$ later than Marth's Ephemeris.

* Having experienced the great serviceableness of these valuable ephemerides, perhaps I may be allowed to suggest that a short prefatory note detailing the data used and the sources from which they are derived would be very useful.

On the Rotation of Saturn in 1894. By A. Stanley Williams.

The observations of spots in 1894 were made and reduced in the same manner and with the precautions described in my paper in the *Monthly Notices*, vol. liv. p. 298 *et seq.* The periods of rotation of the different spots have also been determined in the way indicated in that paper. These periods are based, therefore, upon Mr. Marth's Ephemeris contained in the *Monthly Notices*, vol. liv. p. 163.* The observations attributed to Herr Brenner are the result of measures of two drawings made with the 7-inch refractor of the Manora Observatory, and published in the *English Mechanic*, vol. lx. p. 364. These positions are necessarily only approximate, though they agree closely enough with the other observations to make the identification of the different spots certain. I have assumed the light interspaces between the dark markings shown by Herr Brenner just north of the ring to be identical with the bright equatorial spots. The observations of Mr. G. L. Brown, of Stirling, and Mr. H. MacEwen, of Glasgow, have been communicated to me direct by the respective observers.

The observations of 1894 are on the whole remarkably accordant, the agreement being even more satisfactory than it was in the preceding year. They are in fact so accurate that they have brought to light a rather remarkable peculiarity. On looking through the observations of the different spots it will be noticed as quite a usual thing for those of an individual spot to be best represented not by a uniform period of rotation, but by one with a continual change in its length. In other words, the observations when projected upon a chart are best represented by a slightly curved line, instead of by a straight one, as they should be if the motion of the spot had been uniform. As instances of this peculiarity the bright equatorial spots 1, 2, 5, 6, 8, 10, 11, 13, 15 and the dark northern spots I., II., III., IV., V., VI., VII., VIII., X., may be mentioned. Thus out of twenty-six spots eighteen show the peculiarity in question, which appears to be masked in the case of the remaining spots by the accidental errors of the observations, or from the latter being too few in number or too close together to show it. Only with spots IX. and XI. is there any decided tendency shown of a similar peculiarity, but in the opposite direction.

As to the cause of this rather remarkable feature, it hardly seems likely that it could have been due to a real physical change

* In 1893 the period of rotation corresponding to the Ephemeris was inadvertently assumed to be $10^h\ 13^m{\cdot}64$, instead of $10^h\ 13^m{\cdot}636$, the more correct value. In consequence of this, all the rotation periods of that year contained in the paper referred to above should be diminished by $0^s{\cdot}2$.

on *Saturn*, since the same variation is found both in the equatorial zone and in the zone of the dark northern spots, two regions situated at a great distance from each other and possessed moreover of greatly differing rates of rotation. It may perhaps, with more probability, be ascribed to a change in the personal equation of the observer, there being possibly a tendency for the transits to be observed later in the middle of a series of observations than at the ends, when the spots would be more difficult to observe.

In the tables of observations, the column headed T contains the G.M.T. of transit of the spot, and that headed T′ these times reduced to one date by means of the adopted rotation period of the spot, with, in the following column, the differences from the mean. The other columns explain themselves. The longitudes are derived from Mr. Marth's Ephemeris. The abbreviations used in the descriptive notes are as before : S = small, vS = very small, eS = exceedingly small, B = bright, mB = moderately bright, F = faint, vF = very faint, D = dark, v = very, e = exceedingly, m = moderately.

The Dark Spots in the Northern Hemisphere.

These dark spots were similar to those observed in 1893, and occupied the same situation on a conspicuous double belt in the planet's northern hemisphere. But in 1894 they were observed more frequently to project south of the dark belt into the bright equatorial zone, and to a greater extent. This peculiarity was noted independently by Messrs. Brenner, Brown, and MacEwen. The spots were not seen double so frequently as they had been in the preceding year.

Dark Spot I.

Date.	T.	Long.	Weight.	T′.	Diff.	Period of Rotation.	
	h m	°		h m	m	h m s	
Mar. 4	14 31·6	327·6	1·5	10 43·4	+ 1·4	10 14 62·1	*a*
Apr. 18	10 42·3	53·0	2	42·3	− 0·1	66·1	*b*
27	10 1·3	72·6	1	46·4	+ 4·0	64·7	*c*
May 3	9 32·7	84·9	1	47·7	+ 5·3	63·7	*d*
June 13	9 21·3	154·4	2	32·1	−10·3	55·7	*e*

Description.—(*a*) S, mD, chiefly on south band of the double belt and projecting S. of it, much elong. N. and S. (*b*) vS, F. (*c*) S, F, much elong. N. and S. (*d*) S, mD. (*e*) S, F, elong. N. and S.

Mean period of rotation = $10^h\ 15^m\ 2^s{\cdot}0 \pm 1^s{\cdot}38$ (236 rotations). On three nights the spot was noted as being elongated in a north and south direction.

Dark Spot II.

Date.	T.	Long.	Weight.	T′.	Diff.	Period of Rotation.	
	h m	°		h m	m	h m s	
Feb. 20	16 1·3	321·5	2	12 38·1	− 4·6	10 14 62·1	*a*
Mar. 31	12 45·6	37·6	1	45·6	+ 2·9	58·1	*b*
Apr. 9	11 58·0	53·6	1	44·7	+ 2·0	57·3	*c*
21	10 53·7	74·3	2	42·4	− 0·3	56·3	*d*
June 1	(10 43·2)	145·4	....	(34·9)	(− 7·8)	,...	*e*

Description.—(*a*) vS, eF, projecting south of belt. (*b*) Obs. by MacEwen. Described as a faint spot on the belt, with a very faint streak extending in a s.f. direction from it across the bright equat. zone. (*c*) eS, eF. (*d*) vS, vF. (*e*) Obs. by Brenner. Spot projected south of the belt into the bright equat. zone.

Mean period of rotation = $10^h\ 14^m\ 58^s{\cdot}7 \pm 0^s{\cdot}97$ (140 rotations). On three nights an extension of the spot southwards into the bright equatorial zone was recorded by three different observers.

Dark Spot III.

Date.	T.	Long.	Weight.	T′.	Diff.	Period of Rotation.	
	h m	°		h m	m	h m s	
Mar. 25	13 46·2	43·8	1	11 24·7	− 2·6	10 14 58·9	*a*
Apr. 18	11 41·0	87·5	0·5	25·4	− 1·9	58·4	*b*
21	11 28·4	94·6	1	28·4	+ 1·1	58·6	*c*
June 13	10 25·6	192·1	1	31·3	+ 4·0	56·2	*d*
25	9 20·9	211·0	1	26·6	− 0·7	54·7	*e*

Description.—(*a*) No description possible, def. bad. (*b*) vS, F. (*c*) vS, F. (*d*) Spot seemed plain and to project south of belt, but image dim through haze. (*e*) S, mD, perhaps projecting south of belt.

Mean period of rotation = $10^h\ 14^m\ 57^s{\cdot}2 \pm 0^s{\cdot}57$ (215 rotations). The accordance of the observations is very satisfactory. On two nights the spot seemed to project south of the belt.

Dark Spot IV.

Date.	T.	Long.	Weight.	T′.	Diff.	Period of Rotation.	
	h m	°		h m	m	h m s	
Feb. 20	17 40·5	19·8	1	12 36 7	− 3·3	10 14 60·4	*a*
Mar. 2	13 29·7	41·5	0·5	44·2	+ 4·2	57·9	*b*
16	15 37·0	64·8	2	41·5	+ 1·5	54·7	*c*
Apr. 18	12 40·1	122·1	2	40·1	+ 0·1	54·4	*d*
19	(9 9·3)	123·3	...	(39·5)	(− 0·5)	...	*e*
May 21	9 44·8	178 6	2	37·3	− 2·7	53·9	*f*

Description.—(*a*) vS, eF. (*b*) vS, vF. (*c*) vS, F. (*d*) vS, F. (*e*) Obs. by Brown. The spot projected distinctly into the bright equat. zone. Time from measures of a sketch. (*f*) Two eS, mD spots, the south one suspected to project into the equat. zone.

Mean period of rotation = $10^h\ 14^m\ 55^s{\cdot}4 \pm 0^s{\cdot}73$ (210 rotations). The observations are in very satisfactory agreement.

Dark Spot V.

Date.	T.	Long.	Weight.	T'.	Diff.	Period of Rotation.	
	h m	°		h m	m	h m s	
Feb. 3	16 52·0	28·0	0·5	13 63·1	+ 1·8	10 13 43·9	*a*
Mar. 2	14 14·0	67·5	1	60·5	− 0·8	45·6	*b*
8	13 39·6	76·8	2	60·7	− 0·6	46·0	*c*
22	15 53·3	103·7	3	70·0	+ 8·7	44·5	*d*
29	11 45·2	112·4	0·5	67 1	+ 5·8	44·3	*e*
Apr. 1	11 11·8	107·5	1	50·9	−10·4	44·8	*f*
9	14 1 2	125·9	1	61·2	− 0·1	42·4	*g*
21	12 50·6	142·8	3	59·0	− 2·3	43·4	*h*
May 12	10 50·8	174·1	3	57·9	− 3·4	44·9	*i*
24	9 50·7	196·4	2	64·9	+ 3·6	47·9	*j*
30	9 11·0	201·8	0·5	58·5	− 2 8	43·9	*k*

Description.—(*a*) vS, F, chiefly on south band of the double belt. (*b*) vS, vF. (*c*) vS, F. (*d*) vS, mD. (*e*) Def. confused, no description possible. (*f*) vS, mD, chiefly on south band. (*g*) vS, F. (*h*) vS, F. (*i*) Two eS, mD, spots lying N. and S. (*j*) vS, mD, much elong. N. and S. (*k*) eS, F, on south band only.

Mean period of rotation = $10^h\ 14^m\ 44^s{\cdot}8 \pm 0^s{\cdot}30$ (271 rotations). The observations are in very satisfactory agreement with the exception of those of March 22, 29, and April 1, and it is probable that even these apparently discordant observations were due to a temporary displacement of the spot. On two nights the spot was noted as being situated chiefly on the south band of the double belt, whilst on a third night it was only seen on this southernmost band. The descriptions on May 12 and 24 also agree well, poor definition on the latter night not having allowed the spot to be seen double.

Dark Spot VI.

Date.	T.	Long.	Weight.	T'.	Diff.	Period of Rotation.	
	h m	°		h m	m	h m s	
Apr. 1	11 47·0	128·1	1	11 47·0	− 0·9	10 14 45·2	*a*
18	13 35 6	154·7	2	48·9	+ 1·0	43·4	*b*
27	12 43·1	167·6	2	47·9	0·0	42·5	*c*

Description.—(*a*) No description possible, def. bad. (*b*) vS, F. (*c*) vS, F.

Mean period of rotation = $10^h\ 14^m\ 43^s{\cdot}4 \pm 0^s{\cdot}47$ (61 rotations). Observations very accordant.

Dark Spot VII.

Date.	T.	Long.	Weight.	T′.	Diff.	Period of Rotation.	
	h m	°		h m	m	h m s	
Mar. 17	13 38·2	120·0	2	13 40·9	− 3·5	10 14 45·9	*a*
23	(12 52·5)	122·5	1	(30·0)	(−14·4)	...	*b*
Apr. 21	13 46·4	175·6	3	46 4	+ 2·0	43·2	*c*
27	13 11·6	184·3	3	46·0	+ 1·6	43·1	*d*
May 21	10 54·2	219·4	0·5	44·8	+ 0·4	42·5	*e*
30	10 2·8	232·2	2	43·9	− 0·5	42·2	*f*

Description.—(*a*) vS, mD. (*b*) No description possible, def. bad. (*c*) S, F. (*d*) S, F. (*e*) Inconspicuous, but def. bad. (*f*) S, F.

Mean period of rotation = $10^h\ 14^m\ 43^s{\cdot}5 \pm 0^s{\cdot}42$ (173 rotations). The observations are very accordant with the exception of that of March 23, which was made under very unfavourable circumstances. On three nights the spot was recorded as S. on the scale of size, which is unusually large for a spot on *Saturn*.

Dark Spot VIII.

Date.	T.	Long.	Weight.	T′.	Diff.	Period of Rotation.	
	h m	°		h m	m	h m s	
Feb. 18	16 32·5	90·1	0·5	11 42·8	− 2·7	10 14 53·0	*a*
Mar. 2	15 36·3	115·8	3	54·8	+ 9·3	48·7	*b*
Apr. 10	11 46·2	171·5	1	46·2	+ 0·7	42·9	*c*
May 1	9 42·6	201·0	1	40·7	− 4·8	42·0	*d*
4	9 28·0	207·0	0·5	42 9	− 2·6	43·6	*e*
10	(8 52·5)	215·1	...	(40·7)	(− 4·8)	...	*f*

Description.—(*a*) vS, F. (*b*) vS, F. (*c*) vS, mD. (*d*) S, mD. (*e*) S, F. (*f*) Very rough, spot a long way past transit when observed.

Mean period of rotation = $10^h\ 14^m\ 46^s{\cdot}5 \pm 1^s{\cdot}18$ (175 rotations).

Dark Spot IX.

Date.	T.	Long.	Weight.	T′.	Diff.	Period of Rotation.	
	h m	°		h m	m	h m s	
Mar. 29	14 6·0	195·0	0·5	12 23·5	+ 0·6	10 15 51·8	*a*
Apr. 2	10 33·0	209·6	2	29·5	+ 6·6	47·8	*b*
28	12 19·6	278·6	3	19·6	− 3·3	40·4	*c*
May 4	11 54·2	292·7	1	14·4	− 8·5	30·1	*d*
7	11 57·1	308·9	1·5	27·4	+ 4·5	51·4	*e*
June 1	(7 0)	14·5	...	(17·8)	(− 5·1)	...	*f*

Description.—(*a*) Probably vS, F, but def. bad. (*b*) Two eS, mD, rather well def. spots. (*c*) Two eS, mD, rather well def. spots. (*d*) vS, F, rather well defined. (*e*) S, F. (*f*) Obs. by Brenner.

Mean period of rotation = $10^h\ 15^m\ 43^s{\cdot}7 \pm 2^s{\cdot}30$ (91 rotations). Observations not so accordant as usual. The descriptions on two nights, April 2 and 28, are identical and peculiar.

Dark Spot X.

Date.	T.	Long.	Weight.	T′.	Diff.	Period of Rotation.	
	h m	°		h m	m	h m s	
Apr. 10	14 14·0	258·2	1	10 27·2	− 0·8	10 15 63·8	*a*
17	10 35·3	284·1	1	35·3	+ 7·3	51·9	*b*
28	13 13·3	310·1	0·5	21·4	− 6·6	32·5	*c*

Description.—(*a*) vS, F. (*b*) S, mD. (*c*) Probably S, F.

Mean period of rotation = $10^h\ 15^m\ 52^s{\cdot}7 \pm 5^s{\cdot}46$ (42 rotations).

Dark Spot XI.

Date.	T.	Long.	Weight.	T′.	Diff.	Period of Rotation.	
	h m	°		h m	m	h m s	
Feb. 18	17 54·1	138·0	2	16 54·9	+10·3	10 15 49·8	*a*
Mar. 2	17 5·3	168·0	3	45·4	+ 0·8	49·1	*b*
8	16 44·5	185·3	1·5	44·5	− 0·1	47·2	*c*
23	15 50·3	226·9	1	39·6	− 5·0	44·8	*d*
Apr. 1	15 20·3	253·3	0·5	39·1	− 5·5	42·5	*e*
2	11 56·9	258·8	2	44·1	− 0·5	49·1	*f*

Description.—(*a*) vS, F, susp. dup. (*b*) vS, F. (*c*) vS, mD, probably dup. (*d*) No description possible, def. bad. (*e*) Same as *d*. (*f*) vS, F.

Mean period of rotation = $10^h\ 15^m\ 48^s{\cdot}2 \pm 0^s{\cdot}59$ (100 rotations). The observations are in satisfactory agreement with the exception of the first.

In 1893 the dark northern spots formed two distinct classes or groups, according to the lengths of their periods of rotation. The same peculiarity presents itself with regard to the spots observed in 1894, with the difference that we have here three quite distinct groups.

	No.	Period of Rotation.	No. of Rotations.
		h m s s	
Group A	I.	10 14 62·0 ± 1·38	236
	II.	10 14 58·7 ± 0·97	140
	III.	10 14 57·2 ± 0·57	215
	IV.	10 14 55·4 ± 0·73	210
Group B	V.	10 14 44·8 ± 0·30	271
	VI.	10 14 43·4 ± 0·47	61
	VII.	10 14 43·5 ± 0·42	173
	VIII.	10 14 46·5 ± 1·18	175
Group C	IX.	10 15 43·7 ± 2·30	91
	X.	10 15 52·7 ± 5·46	42
	XI.	10 15 48·2 ± 0·59	100

Combining the different results, the following are the final values for the three groups :

	h	m	s	s	
Group A. Mean Period of Rotation =	10	14	57·29	± 0·68	(4 spots)
„ B. „ „ „ =	10	14	44·23	± 0·30	(4 spots)
„ C. „ „ „ =	10	15	47·97	± 0·60	(3 spots).

The different results composing each group agree closely *inter se*, as they did in 1893, and the different groups are quite distinct from each other. Hence the surface material of *Saturn* must have rotated in 1894, as in 1893, at widely differing rates in the same north latitude, but at different parts of the planet. Taking the date 1894 April 20 as epoch, the spots of group A extend from longitude 30° to 130° ; those of group B from longitude 140° to 200° ; and those of group C from longitude 240° to 360°, all according to Mr. Marth's Ephemeris. The extent in latitude of the northern spot zone is approximately from 17° N. to 37° N. It is worth noting that the periods of the four spots of group A become progressively less and less. This peculiarity is perhaps due to the influence of the more swiftly moving group B, the spots IV. and V. having approached very near one another towards the end of the observations.

The three groups being of nearly equal importance, the average period of rotation for the whole northern spot zone in 1894 may be found by taking the mean of the periods of these three groups. For 1893 I have taken the mean of the two groups A and B of that year. The following is a comparison of the results :

	h	m	s	
1893 Mean Rot. Per. =	10	14	44·7	(10 spots)
1894 „ „ „ =	10	15	9·8	(11 spots),

the difference being + 25^{s}·1.

With respect to the identification of the spots of 1894 with those observed in 1893, it is not possible to do this with certainty as regards the individual spots on account of the long interval separating the two series of observations, and the great changes that have occurred. But it is otherwise with respect to certain of the *groups* of spots. Thus, group A of 1894 has very nearly the same rotation period as group B of 1893 (10^{h} 14^{m} 57^{s}·3 compared with 10^{h} 15^{m} 0^{s}·5), and by calculating back the position of the former group, it appears that this group is in fact identical with the preceding part of group B, 1893, the spots which formed the following part of the last-named group having apparently disappeared.

Similarly group B of 1894 appears to be identical with group A of 1893, though there has been an increase in the period of rotation amounting to 15^{s}. Here also about half the spots of the last-named group seem to have disappeared.

The Bright Equatorial Spots.

The bright equatorial spots of 1894 were similar in appearance and position to those observed in 1893. Owing to the ring system being more open, they were perhaps rather better seen than they had been in the latter year. A narrow dark belt, approximately marking the planet's equator, was frequently observed to cut across the bright spots, dividing them into two parts.

Bright Spot 1.

Date.	T.	Long.	Weight.	T′.	Diff.	Period of Rotation.	
	h m	°		h m	m	h m s	
Feb. 18	15 35·4	56·6	2	13 24·7	+ 0·4	10 13 6·8	*a*
Mar. 2	13 39·7	47·4	3	23·8	− 0·5	8·2	*b*
16	14 54·1	39·7	1	28·0	+ 3·7	7·8	*c*
25	13 30·2	34·4	0·5	30·2	+ 5·9	6·5	*d*
Apr. 18	9 29·5	10·3	1	18·7	− 5·6	1·7	*e*
May 16	11 54·7	350·8	1	20·3	− 4·0	4·7	*f*
June 1	(6 7·6)	343·7	...	(27·8)	(+ 3·5)	...	*g*

Description.—(*a*) vS, F. (*b*) vS, F. (*c*) vS, mB, yellowish. (*d*) Probably vS, mB. (*e*) vS, mB. (*f*) vS, F. (*g*) Obs. by Brenner.

Mean period of rotation = $10^h\ 13^m\ 6^s{\cdot}5 \pm 0^s{\cdot}63$ (204 rotations). The spot was rather a bright one.

Bright Spot 2.

Date.	T.	Long.	Weight.	T′.	Diff.	Period of Rotation.	
	h m	°		h m	m	h m s	
Mar. 8	13 33·8	73·4	2	11 47·8	0·0	10 12 58·4	*a*
16	15 32·7	62·3	2	40·0	− 7·8	63·8	*b*
Apr. 9	11 52·6	50·4	3	52·6	+ 4·8	64·0	*c*
18	10 25·9	43·4	2	52·9	+ 5·1	67·7	*d*
21	9 49·9	36·8	1	45·8	− 2·0	59·2	*e*
June 1	(7 0)	14·5	...	(63·8)	(+ 16·0)	...	*f*

Description.—(*a*) S, F, seen plainly. (*b*) vS, F, well seen. (*c*) S, F, plain. (*d*) vS, F, plain. (*e*) vS, mB, creamy white. (*f*) Obs. by Brenner.

Mean period of rotation = $10^h\ 13^m\ 3^s{\cdot}1 \pm 1^s{\cdot}09$ (103 rotations). The spot was rather a plain one.

Bright Spot 3.

Date.	T.	Long.	Weight.	T′.	Diff.	Period of Rotation.	
	h m	°		h m	m	h m s	
Feb. 18	17 33·7	126·0	2	15 36·4	0·0	10 13 0·7	*a*
Mar. 2	15 35·9	115·6	3	35·9	− 0·5	1·2	*b*
22	15 45·5	99·1	1·5	36·9	+ 0·5	1·9	*c*

Description.—(*a*) eS, F. (*b*) vS, F. (*c*) vS, F.

Mean period of rotation = $10^h\ 13^m\ 1^s{\cdot}2 \pm 0^s{\cdot}21$ (75 rotations). Observations very accordant.

Bright Spot 4.

Date.	T.	Long.	Weight.	T′.	Diff.	Period of Rotation.	
	h m	°		h m	m	h m s	
Mar. 29	11 49·9	115·2	1	13 19·2	+ 1·0	10 12 40·6	*a*
Apr. 9	13 17·0	100·0	0·5	17·0	− 1·2	42·6	*b*
21	11 13·5	85·9	3	18·5	+ 0·3	44·8	*c*

Description.—(*a*) Probably mB. (*b*) eS, eF. (*c*) vS, vF.

Mean period of rotation = $10^h\ 12^m\ 43^s{\cdot}6 \pm 0^s{\cdot}84$ (54 rotations). Observations very accordant.

Bright Spot 5.

Date.	T.	Long.	Weight.	T′.	Diff.	Period of Rotation.	
	h m	°		h m	m	h m s	
Mar. 2	16 58·0	163·7	3	11 37·6	− 4·1	10 12 41·9	*a*
26	12 47·5	134·3	0·5	43·5	+ 1·8	37·3	*b*
Apr. 1	11 41·3	124·8	1	41·3	− 0·4	37·9	*c*
18	12 8·6	103·7	2	45·4	+ 3·7	37·9	*d*
27	10 28·6	88·6	3	40·8	− 0·9	34·5	*e*
June 1	(7 52·4)	45·2	...	(48·9)	(+ 7·2)	...	*f*

Description.—(*a*) vS, F. (*b*) mL, mB. (*c*) No description possible, def. bad. (*d*) vS, F. (*e*) vS, mB, irregular on edges and ill def. with 320; well def. with 225. (*f*) Obs. by Brenner.

Mean period of rotation = $10^h\ 12^m\ 38^s{\cdot}1 \pm 0^s{\cdot}99$ (131 rotations). Spot rather a conspicuous one.

Bright Spot 6.

Date.	T.	Long.	Weight.	T′.	Diff.	Period of Rotation.	
	h m	°		h m	m	h m s	
Mar. 8	16 50·0	188·5	1·5	9 24·2	− 0·4	10 12 40·6	*a*
26	13 41·1	165 7	3	26 6	+ 2·0	39·7	*b*
Apr. 19	9 27·0	133·7	1	27·0	+ 2·4	38·6	*c*
May 26	9 40·5	80·0	1	20·9	− 3·7	36·7	*d*
June 1	(8 44·5)	76·4	...	(28·4)	(+ 3·8)	...	*e*

Description.—(*a*) vS, F. (*b*) vS, F, plain. (*c*) Small and most difficult to see. It appeared only about 0″·5 in diam. Obs. by Brown. (*d*) S, eF, irregular on edges, yellowish. (*e*) Obs. by Brenner.

Mean period of rotation = $10^h\ 12^m\ 39^s{\cdot}3 \pm 0^s{\cdot}49$ (185 rotations). Observations in excellent agreement. The spot was observed by three observers.

Bright Spot 7.

Date.	T.	Long.	Weight.	T′.	Diff.	Period of Rotation.	
	h m	°		h m	m	h m s	
Mar. 21	12 43·2	227·2	1	10 24·8	− 1·9	10 11 73·9	*a*
23	15 53·7	228·9	1	34·3	+ 7·6	54·8	*b*
26	15 5·5	215·2	1	20·7	− 6·0	91·6	*c*
29	14 36·3	212·8	1	26·1	− 0·6	81·5	*d*
Apr. 2	10 28·0	206·6	1	28·0	+ 1·3	80·8	*e*
10	12 18·3	190·4	4	26·4	− 0·3	75·0	*f*

Description.—(*a*) vS, mB, def. bad. (*b*) Probably mB, def. bad. (*c*) Inconspicuous, spot only glimpsed faintly, def. bad. (*d*) Inconspicuous, def. very bad. (*e*) S, F. (*f*) vS, mB, plain.

Mean period of rotation = $10^h\ 12^m\ 15^s{\cdot}8 \pm 2^s{\cdot}76$ (47 rotations). The first four observations were made under very unfavourable conditions, definition on each night being bad. Considering this circumstance, the observations are in good agreement.

Bright Spot 8.

Date.	T.	Long.	Weight.	T′.	Diff.	Period of Rotation.	
	h m	°		h m	m	h m s	
Feb. 20	15 13·3	293·4	3	13 4·4	− 0·6	10 12 23·7	*a*
Apr. 27	13 5 6	180 8	3	5·6	+ 0·6	23·2	*b*
May 12	10 18·0	154·9	1	5·1	+ 0·1	23·1	*c*

Description.—(*a*) vS, mB, plain. (*b*) vS, F. (*c*) S, mB, unusually plain.

Mean period of rotation = $10^h\ 12^m\ 23^s{\cdot}4 \pm 0^s{\cdot}12$ (190 rotations). Observations very accordant.

Bright Spot 9.

Date.	T.	Long.	Weight.	T′.	Diff.	Period of Rotation.	
	h m	°		h m	m	h m s	
Mar. 24	13 9·9	257·7	3	11 27·6	− 0·1	10 12 19·9	*a*
Apr. 2	11 27·5	241·5	0·5	27·5	− 0·2	20·0	*b*
May 1	9 23·5	189·8	1	28·0	+ 0·3	20·3	*c*

Description.—(*a*) vS, F. (*b*) vS, F. (*c*) Probably mB, def. bad.

Mean period of rotation = $10^h\ 12^m\ 20^s{\cdot}0 \pm 0^s{\cdot}08$ (89 rotations). Observations remarkably accordant.

Bright Spot 10.

Date.	T.	Long.	Weight.	T′.	Diff.	Period of Rotation.	
	h m	°		h m	m	h m s	
Feb. 20	16 28·5	337·5	3	14 8·6	− 0·4	10 12 23·5	*a*
Mar. 4	14 8·9	314·3	0·5	3·3	− 5·7	26·0	*b*
Apr. 2	12 17·3	270·7	1	12·1	+ 3·1	24·2	*c*
10	14 6·0	253·6	0·5	6·0	− 3·0	25·2	*d*
May 4	9 48·8	219·2	3	15·8	+ 6·8	27·1	*e*
7	9 9·0	210·3	0·5	9·3	+ 0·3	25·1	*f*
24	9 23·9	180·7	1	7·6	− 1·4	22·7	*g*
June 13	(9 0·0)	141·9	0·5	(13 58·9)	(−10·1)	...	*h*

Description.—(*a*) vS, F, plain. (*b*) S, F, plain. (*c*) vS, vF ? def. bad. (*d*) vS, F. (*e*) vS, mB. (*f*) vS, vB, seen brightly. (*g*) vS, mB, white, well seen. (*h*) Probably vS, F, very rough obs.

Mean period of rotation = $10^h\ 12^m\ 24^s{\cdot}9 \pm 0^s{\cdot}46$ (218 rotations). A plain spot.

Bright Spot 11.

Date.	T.	Long.	Weight.	T′.	Diff.	Period of Rotation.	
	h m	°		h m	m	h m s	
Feb. 3	16 31·5	16·0	0·5	9 43·7	− 4·7	10 12 27·8	*a*
Apr. 17	9 46·1	255·2	3	46·1	− 2·3	25·7	*b*
May 7	9 38·6	227·7	3	56·5	+ 8·1	25·2	*c*
June 13	9 31·0	160·1	2	47·3	− 1·1	23·3	*d*

Description.—(*a*) S, mB, plain. (*b*) vS, mB. (*c*) vS, F. (*d*) vS, mB, well def., plain.

Mean period of rotation = $10^h\ 12^m\ 25^s{\cdot}1 \pm 0^s{\cdot}45$ (305 rotations). A bright spot.

Bright Spot 12.

Date.	T.	Long.	Weight.	T′.	Diff.	Period of Rotation.	
	h m	°		h m	m	h m s	
Mar. 16	12 54·2	329·3	2	9 26·6	+ 6·2	10 12 19·9	*a*
May 10	9 17·5	229·7	0·5	17·5	− 2·9	25 7	*b*
12	12 17·3	224·9	2	15·4	− 5·0	28·3	*c*
24	10 11·2	208·4	1	22·3	+ 1·9	30·7	*d*

Description.—(*a*) vS, F, yellowish. (*b*) vS, mB. (*c*) vS, F. (*d*) vS, vF.

Mean period of rotation = $10^h\ 12^m\ 23^s{\cdot}5 \pm 1^s{\cdot}72$ (162 rotations).

Bright Spot 13.

Date.	T.	Long.	Weight.	T′.	Diff.	Period of Rotation.	
	h m	°		h m	m	h m s	
Feb. 3	17 39·7	56·0	1	10 41·9	− 2·3	10 12 22·6	*a*
20	17 56·5	29·2	0·5	47·2	+ 3·0	19·7	*b*
Mar. 4	15 33·9	4·2	0·5	40·4	− 3·8	21·6	*c*
21	15 44·5	334·2	0·5	40·4	− 3·8	23·2	*d*
Apr. 17	10 37·0	285·1	1	37·0	− 7·2	22·5	*e*
28	12 12 8	274·6	3	52·6	+ 8·4	23·5	*f*
May 1	11 41·0	270·5	1	54·3	+ 10·1	23·4	*g*
7	10 19·0	251·4	1	39·6	− 4·6	21·7	*h*
10	9 54·2	251·3	4	48·3	+ 4·1	23·7	*i*
30	9 27·5	211·5	4	40·5	− 3·7	17 0	*j*

Description.—(*a*) vS, vF. (*b*) vS, vF. (*c*) No description possible, def. bad. (*d*) Same as *c*. (*e*) vS, F, plain. (*f*) S, F, irregular on edges, plain.

(*g*) No description possible, def. bad. (*h*) vS, vF. (*i*) eS, F, fading off and irregular on the edges. (*j*) vS, mB, fading off on edges.

Mean period of rotation = $10^h\ 12^m\ 21^s{\cdot}6 \pm 0^s{\cdot}61$ (272 rotations). The observations are rather discordant, but this is due chiefly to the fact that the motion of the spot was evidently not uniform. The spot appears to have rotated rather more swiftly than would accord with the above period between February 3 and April 17. There then occurred a sudden shift to the east, producing between April 17 and 28 a difference of over a quarter of an hour in the time of transit, whilst subsequently to the latter date the former more rapid motion of the spot was resumed. The nature of the change closely resembles that which occurred in the case of spot No. 1 of 1893.* On three nights the spot was particularly noted as fading off on the edges, whilst on two nights it was seen to be irregular on the edges.

Bright Spot 14.

Date.	T.	Long.	Weight.	T′.	Diff.	Period of Rotation.	
	h m	°		h m	m	h m s	
May 4	11 35·5	281·8	0·5	10 30·1	+ 0·1	10 12 29·1	*a*
10	10 29·8	272·2	2	29·8	− 0·2	29·2	*b*
June 25	9 1·4	199·5	0·5	30·2	+ 0·2	29·3	*c*

Description.—(*a*) vS, vF. (*b*) vS, F. (*c*) vS, mB.

Mean period of rotation = $10^h\ 12^m\ 29^s{\cdot}2 \pm 0^s{\cdot}03$ (122 rotations). Observations very accordant.

Bright Spot 15.

Date.	T.	Long.	Weight.	T′.	Diff.	Period of Rotation.	
	h m	°		h m	m	h m s	
Mar. 22	13 23·9	16·1	3	11 50·2	+ 0·2	10 12 31·6	*a*
Apr. 9	10 8·5	349·4	0·5	51·9	+ 1·9	31·1	*b*
May 7	11 53·0	306·5	2	53·0	+ 3·0	30·2	*c*
June 25	9 46·4	225·9	0·5	44 8	− 5·2	28·1	*d*

Description.—(*a*) vS, F. (*b*) vS, vF. (*c*) vS, F. (*d*) vS, F.

Mean period of rotation = $10^h\ 12^m\ 30^s{\cdot}8 \pm 0^s{\cdot}40$ (223 rotations).

The foregoing bright equatorial spots fall into three distinct groups or classes, as under :

	No.	Period of Rotation.	No. of Rotations.
		h m s s	
Group *a*	1	10 13 6·5 ± 0·63	204
	2	10 13 3·1 ± 1·09	103
	3	10 13 1·2 ± 0·21	75

* See *Monthly Notices*, vol. liv. p. 310.

	No.	Period of Rotation. h m s s	No. of Rotations.
Group *b*	4	10 12 43·6 ± 0·84	54
	5	10 12 38·1 ± 0·99	131
	6	10 12 39·3 ± 0·49	185
Group *c*	7	10 12 15·8 ± 2·76	47
	8	10 12 23·4 ± 0·12	190
	9	10 12 20·0 ± 0·08	89
	10	10 12 24·9 ± 0·46	218
	11	10 12 25·1 ± 0·45	305
	12	10 12 23·5 ± 1·72	162
	13	10 12 21·6 ± 0·61	272
	14	10 12 29·2 ± 0·03	122
	15	10 12 30·8 ± 0·40	223

The following are the mean values for the three groups ;

	h m s s	
Group *a*. Mean Period of Rotation =	10 13 1·69 ± 0·70	(3 spots)
„ *b*. „ „ „ =	10 12 40·03 ± 0·91	(3 spots)
„ *c*. „ „ „ =	10 12 25·83 ± 0·86	(9 spots).

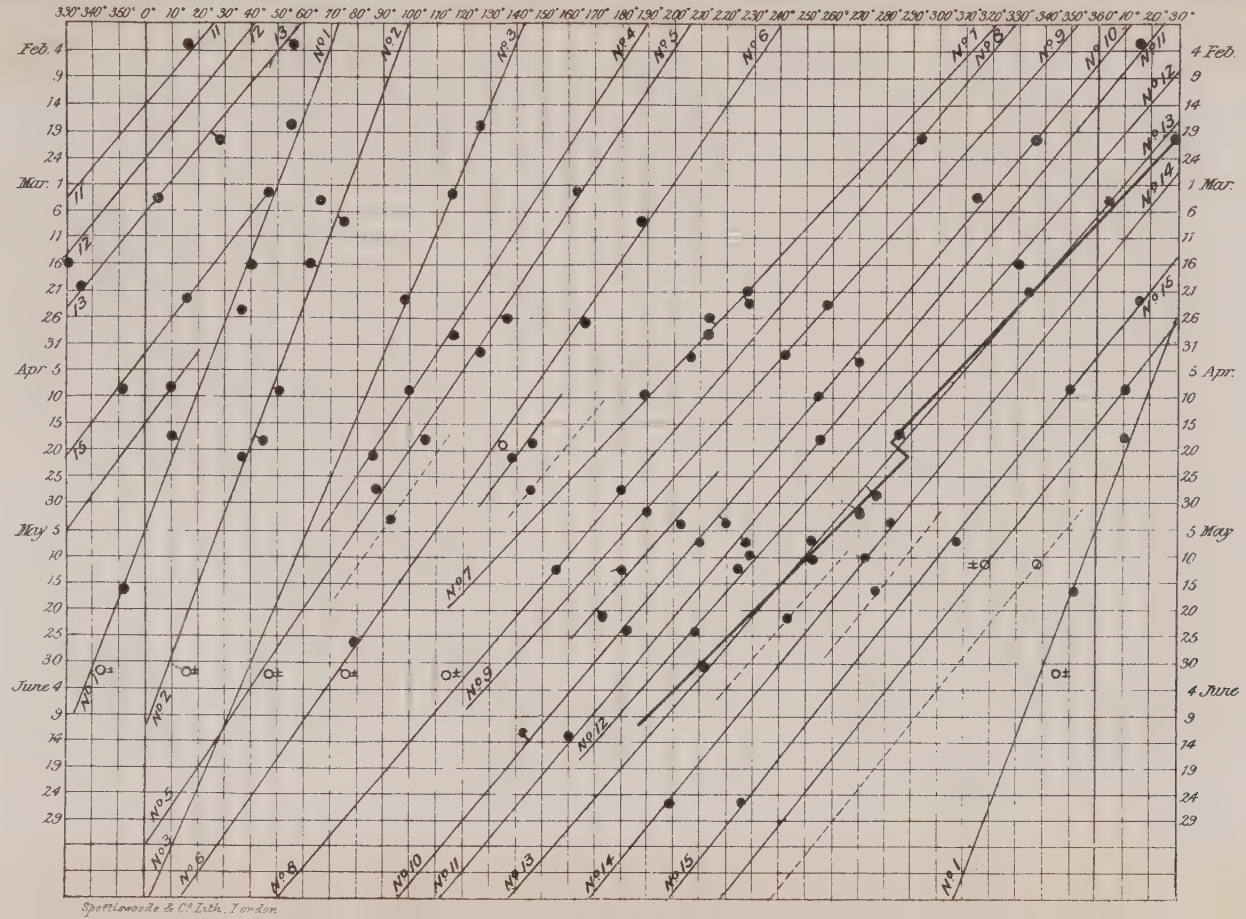
These three groups are all quite distinct from one another. The two last spots of group *c*, Nos. 14 and 15, would appear to form a sub-group, differing somewhat from the remaining spots of this group. For the date 1894 April 20 the spots of group *a* extend from longitude 0° to 80° ; those of group *b* from longitude 80° to 160° ; and those of group *c* from longitude 160° to 360°. The limits of latitude of the equatorial spot zone are approximately 6° N. and 6° S.

In order to find the average period of rotation for the whole spot zone I have taken the mean of the results for these three groups, giving group *c* treble weight. The like result for 1893 has been got by taking the simple mean of group C and spot No. 4 of that year. The following then are the average rotation periods of the whole equatorial spot zone in the different years, the values for 1891 and 1892 being the approximate ones found by Mr. Marth.

	h m s	s
1891 Mean Period of Rotation =	10 14 21·8	Diff. = 43·6
1892 „ „ „ =	10 13 38·2	Diff. = 45·8
1893 „ „ „ =	10 12 52·4	Diff. = 16·6
1894 „ „ „ =	10 12 35·8	

It would appear from the above figures that the rate of decrease in the length of the period is diminishing. Between 1891 and 1894 the decrease amounts to $1^m\ 46^s$. This difference means a very considerable increase in the velocity of motion of

SATURN — Spot Chart for the Bright Equatorial Spots of 1894



the surface material, amounting to 66 miles per hour. In other words, the great equatorial atmospheric current of *Saturn* was blowing 66 miles an hour more quickly in 1894 than it was in 1891.

As in the case of the dark northern spots, it does not seem possible to certainly identify any individual bright spot with those observed in 1893, though it is otherwise as regards the groups. Group *a* of 1894 has nearly the same period as group C of 1893 ($10^h\ 13^m\ 1^s{\cdot}7$ compared with $10^h\ 12^m\ 59^s{\cdot}4$), and by calculating back its position, it appears that the former group is identical with the preceding portion of group C, 1893. The spots which formed the remaining part of the last-mentioned group (including amongst them the spots 1, 2, 3, and 5) had disappeared in 1894.

Group *b* of 1894 is also evidently identical with the region represented by spot 4 of the preceding year. It is even probable that spot 6 of 1894 is the same as spot 4 of 1893, a slight decrease having occurred in the length of its period in the interval. The position of the former spot calculated back to the early part of 1893 June agrees exactly with that of the latter.

The diagram, Plate 7, contains all the observations of the bright equatorial spots which have come to my knowledge, my own observations being represented by dots, and those of other observers by circles. In work of this kind everything, of course, depends upon the correct identification of the different spots. It will be seen from the diagram that the identifications are on the whole very satisfactory. Thus, in the cases of spots 3, 4, 5, 6, 8, 9, 14, and 15, the dots representing the observations are almost, where not actually threaded by the straight lines, drawn through the observations of each spot, whilst in no case do the discordances appear large enough to render the identifications doubtful. The observations are perhaps most discordant in the case of spot 13, but on the hypothesis that a sudden shift occurred in the position of this spot between April 17 and 28, they also come into very satisfactory agreement. This state of things has been indicated in the diagram by thick lines.

Micrometrical Measures of the Ball and Ring System of the Planet Saturn, and Measures of the Diameter of his Satellite Titan. Made with the 36-inch Equatorial of the Lick Observatory. By E. E. Barnard, A.M., Dr. Science.

From the decided advantage in the large scale of our great telescope, it would seem very important that a careful redetermination of the dimensions of the Saturnian Ball and Ring system should be made with it.

Recognising this, I have been anxious to do the work, and have taken advantage of the first opportunity that has occurred: this was the opposition of 1894.

The measures of the planet were taken up in February and carried through until July.

During these observations I sought to measure everything that could be seen about the ball and rings.

The measures have been made with the greatest possible care, and will, I think, represent the best results attainable in this direction with the 36-inch refractor.

The observations confirm the previous measures of this planet, and are specially consistent with the excellent work of Professor Hall, with the 26-inch at Washington, in the years 1884 to 1887.

They show essentially that no change has taken place in the Saturnian System since the first systematic measures were made of it. They also thoroughly prove (as did the measures of Hall) the fallacy of the supposition that the rings are sensibly closing in on the planet.

One important question that I wished to settle in these measures was that of a possible eccentricity of the rings with reference to the ball. It had been previously reported that the ball is not exactly in the centre of the rings.

To determine whether this is true, I made a series of measures of the distance from the ends of the ring to the preceding and following limbs of the planet. The outer edges of the ring were selected because they appeared to be more definite than the inner edge of the inner bright ring. A couple of nights, however, were devoted to measures of this last quantity, with the result of verifying the other measures.

It will be seen that these systematic measures do not show any sensible deviation of the ball from the exact centre of the rings during the opposition of 1894. Hence, if any eccentricity exists it must lie nearly in the line of sight, and cannot therefore be detected with a micrometer.

I also made a set of measures of the distance from the centre of the preceding and following parts of the Cassini division to the nearest limbs of the planet.

It will be seen that the measures of this quantity are accordant, and that each one persistently indicates that this division is eccentric to the ball. The means of these measures would place the ball $0''\cdot25$ towards the preceding portion of the division. (See "Note" at the close of this paper.)

Though the observations are consistent in pointing to this, I do not think it can be accepted as proved that the difference is real. To definitely settle this question I shall make a special series of measures during the coming opposition of *Saturn*.

Physical appearance of Saturn.

The physical appearance of the planet throughout the measures was quite normal.

The black and white spots lately seen upon *Saturn* by various little telescopes were totally beyond the reach of the

36-inch—as well as of the 12-inch—under either good or bad conditions of seeing. One narrow dusky belt alone was visible upon the ball. This was placed near the middle of a broad light equatorial zone, and just north of the trace of the rings.

The light zone was bordered to the north by a rather heavy dusky diffusion extending to the north limb. The southern edge of this—where it met the light zone—was of a warm colour, and gradually diffused into a colder or ashy-hued region that formed the true polar cap, and which was almost definitely bounded at its southern edge. Once or twice a very small and very dark spot was seen *at the North Pole.*

The Crape ring has appeared uniformly even in shade at the two ansæ. It was of a steely blue colour, and was not strongly contrasted with the sky. No markings whatever were seen upon it. The inner edge was a uniform curve ; the serrated or saw-toothed appearance of its inner edge, which had previously been seen with some small telescopes, was also beyond the reach of the 36-inch.

No division was seen between the Crape ring and the inner bright ring, as has sometimes been shown on drawings. This supposed division, however, was proved to have no real existence by my observations of the eclipse of *Japetus* in the shadows of the rings 1889 November 1.

There is no distinct junction between the two rings, though the bright ring is not well defined where it meets the Crape ring. It looks as if there was a very quick diffusion of the inner bright ring into the dusky ring, as if, indeed, the latter were formed at the expense of the bright ring. This peculiarity was also shown to exist by the observations of the eclipse of *Japetus* mentioned. In examining the trace of the Crape ring on the ball one readily sees that the ring is very thin at its inner edge, and that it grows much denser where it joins the bright ring. This increasing density of the Crape ring towards the bright ring was first beautifully shown to be a fact by the observed light curve at the eclipse of *Japetus* in 1889 (see *M.N.* 1890 January, vol. L.).

In the present observations the ball could faintly be seen through a small portion of the projection of the Crape ring, but not up to the bright ring. This trace was, on account of the bright ball behind it, sensibly lighter than where the ring was projected against the dark sky.

The inner portion of the inner bright ring is exactly the same depth of shade as the outer ring. About $\frac{1}{4}$ of its outer edge, next the Cassini division, however, is very bright. Indeed, this portion of the inner ring is brighter than any other part of the ball or rings.

From the southern declination of the planet one or two features previously seen were not readily made out. The division in the outer ring seen by Professor Keeler in 1888 was not visible at any time, though I had seen it in 1889.

The Encke "division" was not seen at the time of my

drawing, though I have seen it before. By the way, I do not think this marking is a real division like that of Cassini. It has always appeared to me to be a rather feeble dark line *on* the ring. But, as I understand, it has been seen on both the south and north faces of the ring. It must therefore penetrate through the ring. It would seem probable that at this point in the rings all the particles for some reason have not been removed, as appears to have occurred in the case of the Cassini division; the "division" would therefore be only partly free of them, or in a similar condition to the Crape ring.

I have made a careful drawing (Plate 8) of the appearance of the planet and his rings during the measures, and have shown only what I have seen with certainty. It is true the picture appears abnormally devoid of details when compared with drawings made with some of the smaller telescopes. I am satisfied, however, to let it remain so.

On several occasions *Saturn* was examined after sunrise or before sunset. Under these conditions, when the air was steady, the details were perhaps better seen than on a dark sky. They were also considerably better seen by using a very small hole in a cap over the eye-piece. The hole that gave the best results was about 0·03 or 0·04 inch in diameter. When the object is bright this always steadies the image by reducing the quantity of light, and hence the effect of atmospheric tremors.

This is also a very useful device for measuring very close double stars with high powers, as it gives neater discs and cuts out a great deal of stray light, at the same time that it makes the micrometer wires sharper. It might be supposed that this is the simple equivalent of placing a diaphragm over the object-glass. This, however, is not so.

Cutting down the aperture of the objective not only reduces the quantity of light, and thus the apparent effect of atmospheric tremors, but it also diminishes the separating power of the objective, and is therefore for many purposes an objectionable method. Diminishing the size of the beam that enters the eye from the eye-piece does not affect the separating power of the object-glass, at the same time that it reduces the amount of light and sharpens the image.

This, indeed, is very fortunate, because it is quite a difficult thing to get at and to diaphragm down the object-glass of a great telescope. There is a series of these small eye-caps here for use with the 36-inch. They can be slipped off and changed in a couple of seconds. Mr. Burnham had these caps made, and always used them in his double-star work.

I have also often examined the planet with the 12-inch, but the view was far finer through the 36-inch, and the details better seen when the air was good.

I also tried diaphragms on the 12-inch—cutting it down as small as 6 inches. Though this steadied the image somewhat, it did not reveal anything not seen with the full aperture.

E.E. Barnard Del^t

36 in. Equatorial

SATURN, JULY 2 1894.

Under good conditions, with the 36-inch, the Cassini division was easily traceable all round the ring, and apparently perfectly black and uniform, without any notches in it.

The shadow of the ball on the rings was uniform in outline, and did not show any difference of level in any of the rings. In a drawing of *Saturn* by Trouvelot in Newcomb's excellent *Popular Astronomy*, the brightest part of the inner bright ring is shown to project into the shadow of the ball, as if that part were at a higher level than the rest of the ring. I think this appearance has been an illusion due to the greater brightness of that part of the ring which by irradiation might cause it to seem to project into the shadow.

An original pastel drawing by Trouvelot, showing nearly the same phase of the rings as that of 1894, belongs to the Lick Observatory. It also shows this apparent projection. This very beautiful picture shows the rings faintly visible in the shadow of *Saturn*. This shadow has always appeared perfectly opaque to me in all telescopes.

In this drawing, from which the engraving in Newcomb's *Popular Astronomy* seems to have been made, Trouvelot has very beautifully shown the present appearance of the bright ring and the Crape ring where they join—very exactly like that observed in the great telescope. The picture in Newcomb's *Popular Astronomy*, however, does not properly represent the telescopic appearance, as the bright ring and Crape ring so gradually merge into each other that no one can tell where one begins or the other leaves off.

In my drawing I have not shown the junction between these two rings any more definite than it appears in the 36-inch. The consistency of my measures of the width of the Crape ring at the two ansæ alone shows that its outer edge, or the inner edge of the bright ring, was fairly definite.

One of the most beautiful and delicate drawings that I have seen of the planet *Saturn* was made, 1886 March 1, by Professor George Davidson, with his 6·4-inch Clark equatorial refractor at San Francisco.

Unfortunately this handsome picture has never been properly reproduced. Professor Davidson has spent a great deal of time and money in endeavours to properly place it before the astronomical world, but from its great delicacy he has not yet been able to do so. Professor Davidson's keen eyesight and well-known accuracy have shown in this picture essentially about as much as can be seen in the largest telescopes. One great thing which must commend itself to every observer familiar with *Saturn* in a telescope is that he has not shown a single abnormal feature.

Micrometrical Measurements.

Equatorial Diameter of Saturn.

1894.	Observed.	MΔ.	δ.
Mar. 25	19″21	17″58	+0″16
Apr. 9	19·50	17·77	−0·03
16	19·52	17·80	−0·06
23	19·33	17·67	+0·07
29	19·44	17·83	−0·09
30	19·29	17·70	+0·04
May 7	19·30	17·81	−0·07
21	19·10	17·89	−0·15
28	18·73	17·71	+0·03
June 11	18·40	17·77	−0·03
18	18·18	17·76	−0·02
25	17·85	17·64	+0·10
		17·744 ± 0·017	

These have been corrected for phase by the aid of Marth's Ephemeris.

The adopted mean distance of *Saturn* from the Sun to which these measures are reduced

$$= M\Delta = 9{\cdot}538861.$$

δ is the deviation from the mean.

Polar Diameter of Saturn.

1894.	Measured Diameter.	MΔ.	Corrected MΔ.	δ.
Mar. 25	17″80	16″29	16″20	+0″11
Apr. 9	17·97	16·38	16·29	+0·02
16	18·02	16·43	16·34	−0·03
23	17·88	16·34	16·26	+0·05
29	17·83	16·35	16·27	+0·04
30	17·80	16·33	16·25	+0·06
May 7	17·84	16·46	16·38	−0·07
21	17·36	16·26	16·18	+0·13
28	17·57	16·61	16·53	−0·23
June 11	16·88	16·30	16·23	+0·08
18	16·90	16·51	16·44	−0·13
25	16·57	16·38	16·31	0·00
			16·307 ± 0·020	

The second column contains the observations reduced to the mean distance from the Sun. The third contains this quantity

corrected for the inclination of the axis towards us. This is the true polar diameter.

Outer Diameter of Outer Ring.

1894.	Measured Diameter.	MΔ.	δ.
May 6	43″·93	40″·50	−0″·21
7	43·52	40·15	+0·13
21	42·98	40·26	+0·02
28	42·72	40·38	+0·09
June 11	41·72	40·28	0·00
18	41·01	40·06	+0·22
25	40·87	40·39	−0·10
July 2	39·91	40·26	+0·02
		40″·285 ± 0″·034	

Outer Edge of Outer Ring and Nearest Limb of Planet.

	Preceding.			*Following.*		
1894.	Measures.	MΔ.	δ.	Measures.	MΔ	δ
Feb. 25	11″·95	11″·23	−0″·03	12″·05	11″·33	−0″·05
26	11·96	11·24	−0·04	11·75	10·89	+0·38
Mar. 11	11·89	11·02	+0·18	12·08	11·19	+0·08
12	12·10	11·17	+0·03	11·92	11·00	+0·27
25	12·45	11·39	−0·19	12·30	11·26	+0·01
Apr. 9	12·36	11·27	−0·07	12·60	11·49	−0·21
16	12·23	11·15	+0·05	12·61	11·50	−0·22
23	12·26	11·21	−0·01	12·46	11·39	−0·11
29	12·16	11·15	+0·05	12·39	11·36	−0·08
May 6	12·28	11·32	−0·12	12·04	11·10	+0·17
21	11·83	11·08	+0·12	12·29	11·51	−0·23
		11″·203			11″·275	

Adding these to the measured equatorial diameter makes the outer diameter of the rings

$$= 40''\cdot222.$$

Diameter, Middle of Cassini's Division.

1894	Measured.	MΔ.	δ.
May 6	37″·48	34″·55	−0″·21
7	37·22	34·34	0·00
21	36·50	34·19	+0·15
28	36·09	34·12	+0·22
June 11	35·58	34·35	−0·01
18	35·24	34·42	−0·08
25	34·80	34·39	−0·05
		34″·337 ± 0″·037	

With this value and the measured width of the division (0″·558) we get for the inner diameter of the outer ring

34″·895;

and outer diameter of the inner bright ring

33″·779.

Inner Edge of Inner Bright Ring to Ball.

	Preceding.		Following.	
	Measured.	MΔ.	Measured.	MΔ.
1894.	″	″	″	″
Apr. 23	4·23	3·87	4·13	3·78
May 6	4·14	3·82	4·18	3·85
		3·845		3·815

Added to the measured equatorial diameter these will also give the following value of the inner diameter of inner bright ring.

25″·404.

Width of Cassini's Division.

	Measured.	MΔ.	δ.
1894	″	″	″
Apr. 23	0·59	0·55	+0·01
29	0·69	0·64	−0·08
30	0·67	0·63	−0·07
May 7	0·34	0·31	+0·25
21	0·35	0·32	+0·24
June 11	0·64	0·62	−0·06
18	0·62	0·61	−0·05
25	0·66	0·65	−0·09
July 1	0·49	0·49	+0·07
2	·	0·57	−0·01
		0·558	

The two measures in May are abnormally small. I have, however, retained them, but have given them only half weight.

In the first five measures the wires were placed so that their outer edges were tangent with the edges of the division; to these I have added 0″·13, the thickness of a micrometer thread. In the rest of the observations the edges of the division were bisected by the middle of the wires.

I have deduced the following values of the width of the Cassini division from previous measures of the rings.

Width of Cassini Division.

Herschel	1792	0″·645
F. Struve	1829	0·407
Bessel	1835	0·402
Decuppis and de Vico ...	1838	0·384
Encke	1838	0·775
O. Struve	1852	0·445
Jacob	1856	0·486
De La Rue	1856	0·940
W. C. Bond	1857	0·455
Hall	1884-7	0·420
	Mean	0·536

which is in close agreement with my own measures.

Centre Cassini's Division to Ball.

	Preceding.			Following.		
	Measured.	MΔ.	δ.	Measured.	MΔ.	δ.
1894.	″	″	″	″	″	″
Apr. 23	8·98	8·21	−0·09	9·13	8·35	+0·02
30	8·91	8·18	−0·06	9·09	8·34	+0·03
May 7	8·65	7·98	+0·14	9·11	8·41	−0·04
		8·123			8·367	

By adding these to the measured equatorial diameter, we also get for the diameter of Cassini's division

$$34''\cdot234.$$

Inner Diameter of Inner Bright Ring.

	Measured.	MΔ.	δ.
1894.	″	″	″
May 7	28·11	25·94	−0·39
21	27·16	25·44	+0·10
28	26·79	25·33	+0·21
June 11	26·36	25·45	+0·09
18	26·20	25·59	−0·04
25	25·82	25·52	+0·02
		25·545	

Width of Crape Ring.

	Preceding. Measured.	MΔ.	δ.	Following. Measured.	MΔ.	δ.
	″	″	″	″	″	″
Apr. 23	2·42	2·21	+0·06	...	...	...
30	...	...	...	2·48	2·28	−0·06
May 6	2·48	2·29	−0·02	2·51	2·31	−0·09
7	2·54	2·34	−0·07	2·46	2·27	−0·05
21	2·29	2·14	+0·13	2·10	2·00	+0·21
June 18	2·34	2·29	−0·02	...	...	...
25	2·25	2·22	+0·05	...	...	...
July 2	2·41	2·43	−0·16	...	...	...
		2·274			2·215	

Subtracting these values from the measured diameter of the inner bright ring, we get for the inner diameter of the Crape ring

21″·056

In the foregoing measures refraction corrections have been applied when appreciable.

Results of the Measures.

Collecting these results, we have the following values of the Saturnian Ball and Ring system from the measures of 1894 with the 36-inch refractor, reduced to the mean distance of *Saturn* from the Sun.

Equatorial Diameter of Saturn	″ 17·744
Polar Diameter of Saturn	16·307
Outer Diameter of Outer Ring	40·249
Inner Diameter of Outer Ring	34·864
Centre of Cassini Division	34·306
Outer Diameter of Inner Ring	33·748
Inner Diameter of Inner Ring	25·522
Inner Diameter of Crape Ring	21·033*
Width of Cassini Division	0·558

In this collection I have adopted the means of the different determinations of several of the quantities, giving weight according to the number of determinations.

To those who would like to see how these measured dimensions of *Saturn* and his rings appear in English miles, the following tabulation will be of interest. These dimensions rest upon the solar parallax derived by Professor Harkness.

From the Observations with the 36-inch.

Equatorial Diameter of Saturn	= 76,150 miles.
Polar Diameter of Saturn...	= 69,980 „
Outer Diameter of Rings	= 172,730 „
Inner Diameter of Outer Ring	= 149,620 „
Outer Diameter of Inner Ring	= 144,830 „
Inner Diameter of Inner Ring	= 109,530 „
Inner Diameter of Crape Ring	= 90,260 „ *
Width of Cassini Division	= 2,395 „

Ellipticity of the Disc of Saturn.

From the equatorial and polar measures we have for the compression or ellipticity of the disc of *Saturn*—

$$\frac{E-P}{E}=\frac{1}{11{\cdot}44}.$$

Professor Hall's Measures.

For comparison with the measures I copy here the work of Professor Hall with the Washington 26-inch refractor from 1884 to 1887.

Equatorial Diameter of Saturn	17″·72 † (13 nights)
Polar Diameter of Saturn	...
Outer Diameter of Outer Ring	40·45 † (18 nights)
Inner Diameter of Outer Ring	34·95
Centre of Cassini Division	34·53 † (17 nights)
Outer Diameter of Inner Ring	34·11
Inner Diameter of Inner Ring	25·75 (5 nights)
Inner Diameter of Crape Ring	20·52 (2 nights)
Width of Cassini Division	0·42 (? nights)

Professor Hall does not give his measures of the width of the Cassini division. It is the difference between our measures of this quantity and the slight difference in the measures of the diameter of the Cassini division that produces the discrepancy in our results for the values of the inner diameter of the outer ring, and the outer diameter of the inner ring. Professor Hall did not measure the polar diameter.

* See "Note, 1895 April 1." That follows this paper, where a smaller diameter is got by direct measures. It should be preferred to the above value.

† The probable errors are respectively ±0″·030, ±0″·042, ±0″·025.

The results of these filar micrometer measures with two of the most powerful telescopes of to-day ought to be strictly comparable. It will be seen that they are in very good accord, as much so, indeed, as can be expected from two different instruments and two different observers in dealing with an object of this kind.

Here are the differences, Hall–Barnard :—

Equatorial Diameter	= −0″02
Outer Diameter of Ring	= +0·20
Inner Diameter of Outer Ring	= +0·09
Centre of Cassini Division	= +0·22
Outer Diameter of Inner Ring	= +0·36
Inner Diameter of Inner Ring	= +0·23
Inner Diameter of Crape Ring	= −0·51
Width of Cassini Division	= −0·14
Mean Difference H−B	= +0 054

The magnifying power used in all the measures was 520. The image was seldom at all good with 1000. From 500 to 700 gave the best results, and often the view was better with 350.

Measures of the Diameter of Titan.

Some measures were also obtained of the diameter of *Titan*. It was seldom, however, that the disc of this satellite could be seen clear enough for measurement. Under such conditions measures would have been useless. The satellite was, therefore, attempted only when its disc could be clearly seen. The measures of this object were made with 1000 diameters, the same power used in my measures of the diameters of *Ceres*, *Pallas* and *Vesta*, and also for the measures of the four bright satellites of *Jupiter*.

I think these measures of *Titan* will be good.

Diameter of Titan.

	Measured.	MΔ.	δ.
	″	″	″
1894 May 6	0·53	0·49	+0·10
7	0·53	0·49	+0·10
June 18	0·62	0·61	−0·02
25	0·75*	0·74	−0·15
July 2	0·60	0·61	−0 02
		0·588 ±0·031	

* Measured with 520 diameters.

This corresponds to a diameter of

2,523 miles,

which is a smaller diameter than has usually been assigned to *Titan*, and would indicate a density about 5·2 times as great as that of *Saturn*.

Conjunctions of Satellites with Ball.

The following careful estimates were made with the aid of a micrometer wire placed perpendicular to the equator of *Saturn*.

Inferior conjunction of *Rhea* and centre of ball, 1894 May $7^d\ 10^h\ 18{\cdot}6^m$ Standard Pacific Time. *Rhea* about 9″ from North limb. Observation good.

Superior conjunction of *Tethys* and centre of ball, 1894 May $7^d\ 11^h\ 2{\cdot}1^m$ Standard Pacific Time. *Tethys* about 3″ from South limb. Observation good.

Inferior conjunction of *Tethys* and centre of ball, 1894 July $15^d\ 8^h\ 40{\cdot}1^m$ Standard Pacific Time. *Tethys* about 2″ from North limb. Observation good.

Mount Hamilton, California:
1895 *January* 27.

Note.—1895 *April* 1.

I am continuing the work of measuring the ball and ring system of *Saturn* through the approaching opposition, and have already secured several sets of measures. They confirm the previous work.

Following are the observations so far obtained:

Centre Cassini Division to Nearest Limb of Planet.

		Preceding			Following		
		Obsd.	M.Δ.	δ.	Obsd.	M.Δ.	δ
Feb.	4	8″·13	8″·16	+0″·10	8″·18	8″·21	+0″·06
	5	8·19	8·20	+0·06	8·12	8·13	+0·14
	18	8·52	8·35	−0·09	8·44	8·27	+0·00
Mar.	3	8·67	8·33	−0·07	8·78	8·44	−0·17
			8·259			8·267	

The values for the "preceding" have been corrected for the phase of the ball.

Adding these to the equatorial diameter of the ball previously obtained gives for the diameter of the Cassini division

34″·270

combining this with the direct measures of this quantity, that follows, we have

$$34''{\cdot}425$$

for the diameter of the Cassini division—in good accord with last year's result.

Outer Diameter of Rings.

	Obsd.	M.Δ.	δ.
1895 Mar. 4	41″·97	40″·28	+0″·01
10	42·12	40·06	+0·21
24	43·25	40·48	−0·21
		40·273	

Diameter Centre Cassini Division.

	Obsd.	M.Δ.	δ.
1895 Mar. 4	36″·03	34″·58	0″·00
10	36·24	34·47	+0·11
24	37·08	34·70	−0·12
		34·583	

Inner Diameter Inner Bright Ring.

	Obsd.	M.Δ.	δ.
1895 Mar. 4	26″·85	25″·77	−0″·13
10	26·99	25·67	−0·03
24	27·22	25·47	+0·17
		25·637	

Inner Diameter of the Crape Ring.

	Obsd.	M.Δ.	δ.
1895 Mar. 4	21″·36	20″·50	−0″·06
10	21·57	20·51	−0·07
24	21·69	20·30	+0·14
		20·437	

It will be seen that this value is about $\frac{1}{2}$ a second smaller than that previously derived from the measures of the width of the crape ring at the ansæ and the measured diameter of the inner bright ring.

The above values are direct measures of the inner diameter of the crape ring, and are to be preferred to the value of 1894, though it differs considerably from that result. It is not always an easy object to measure, but I think a direct measure of it is best. Determining its diameter in the roundabout way employed in 1894 is subject to an accumulation of errors that the direct measures are free from.

Equatorial Diameter of Ball.

	Obsd.	M.Δ.	δ.
1895 Mar. 4	18″·43	17″·59	+0″·12
10	18·86	17·94	−0·13
		17·815	

This is corrected for phase.

Polar Diameter of Ball.

	Obsd.	M.Δ.	δ.
1895 Mar. 4	17″·12	16″·43	−0″·13
10	17·01	16·18	+0·12
		16·395	

This is not corrected for the elevation of the Earth above the pole of *Saturn*.

It will be seen that these new measures of the position of the ball with reference to the Cassini division, which were made specially to settle the question of any eccentricity of this division, as such seemed to be indicated in the measures of last year, show that the difference in the previous measures of these quantities was simply due to peculiarities in the measures themselves; for the present measures of the distance preceding and following are identical. All the measures therefore go to show that the ball is symmetrically placed in the rings.

Appearance of the Planet in 1895.

The increased opening out of the rings makes the planet a superb object now with the great telescope.

The finest view I have ever had of *Saturn* was on the morning of April 1.

Saturn, 1895 March 31.
(36-inch telescope of the Lick Observatory.)

A stiff south wind was blowing directly on the telescope and making measures impossible, but the definition was superb. During moments of steadiness the view was a sublime one, and impressed me more with the wonderful power of our great telescope than anything else, perhaps, that I have seen through it.

No abnormal features, however, were visible, either upon the rings or on the ball.

The narrow dark belt near the equator, shown in my drawing for 1894, was very distinct, but the space between it and the north dusky region seemed narrower.

This region north of it is really now a very broad warmish dusky belt distinctly terminated at its north edge, which lies about halfway from the trace of the crape ring to the north pole. From the north edge of this belt the surface of the ball was of an exceedingly delicate light yellow, apple-green colour. But at the pole there was a small, very heavily marked dark cap, which was nearly as dark as the crape ring against the sky. This small dark cap was strikingly and sharply defined in outline. I had seen this previously this year, and also last year, but not near so distinctly.

The Encke "division" was seen faintly at both ansæ, but more distinctly following. It was nearly as broad as the Cassini division.

The shadow of the ring on the ball was not visible, but the shadow of the ball on the ring was noticeable preceding the ball. It was narrow, slightly concave, and concentric with the ball. At the following side there was a darkening of the ring and the ball suggestive of the faintest trace of the shadow on that side.

The trace of the crape ring was pale and the ball was easily seen through it up to the bright ring. On the sky it was clearly defined, very distinct, and of a steely blue colour.

1895 *April* 1.

Filar Micrometer Measures of the Diameters of the Four Bright Satellites of Jupiter, made with the 36-inch Equatorial of the Lick Observatory. By E. E. Barnard, A.M., Dr. Science.

The great power and large scale of the 36-inch make it very suitable for measuring very small quantities, such, for instance, as the diameters of the larger asteroids, the satellites of *Jupiter*, and so on.

In connection with my other work on the planet *Jupiter*, I began a series of micrometer measures of the diameters of the four bright satellites with the 36-inch.

These have been continued until the bad weather put a stop to the work. It is scarcely probable that any more satisfactory measures of these satellites will be obtained this winter ; I have, therefore, collected and reduced the observations as final.

A power of 1,000 has been uniformly used, and unless the night would permit the use of this magnifying power, and give distinctly defined discs, no measures were attempted.

The measures in each case were made by the method of double distances, three to four settings, before and after reversal of the wires, being made.

The endeavour in these observations has been to exactly bisect the limbs of the satellites with the centres of the wires. This, I think, can be done with an extremely small percentage of error. I should think this method more accurate than that of bringing the insides or the outsides of the wires tangent to the limbs, and then correcting for the thickness of the wires. If the images were absolutely steady and permitted one to deliberately bring the edges of the wires in exact tangency, then that method would be preferred. This condition of things, however, essentially never occurs. The thickness of the micrometer wires in the 36-inch micrometer is about $0''\cdot1$.

Following are the details of the measures.

The full aperture of the 36-inch, as always, has been used.

Satellite I.

1894.	Apparent Diam.	At Δ 5.20.	Deviation from Mean.
	″	″	″
Oct. 21	1·08	0·97	+0·08
28	1·02	1·12	−0·07
29	1·13	0·99	+0·08
Nov. 4	1·19	1·07	−0·02
5	1·33	1·14	−0·09
12	1·27	1·07	−0·02
18	1·24	1·03	+0·02
19	1·19	0·99	+0·06
Mean		1·048	

The measured diameters of this satellite are all *equatorial*, except on the following dates, November 4, 5, 18, when the *polar* diameter was measured.

Satellite II.

1894.	Apparent Diam.	At Δ 5.20.	Deviation from Mean.
	″	″	″
Oct. 21	0·82	0·73	+0·14
28	0·93	0·81	+0·06
29	0·96	0·84	+0·03
Nov. 4	1·05	0·90	−0·03
5	1·21	1·04	−0·17
12	1·10	0·93	−0·06
18	1·03	0·85	+0·02
19	1·08	0·89	−0·02
Mean		0·874	

All the measures of this satellite are *polar*.

Satellite III.

1894.	Apparent Diam.	At Δ 5.20.	Deviation from Mean.
Oct. 21	1″·85	1″·66	−0″·14
28	1·60	1·40	+0·12
29	1·66	1·45	+0·07
Nov. 4	1·77 (Equ.)	1·50	+0·02
4	1·73 (Pol.)	1·46	+0·06
5	2·03	1·74	−0·22
11	1·86	1·57	−0·05
12	1·77	1·49	+0·03
18	1·79	1·49	+0·03
19	1·86	1·54	−0·02
Dec. 23	1·79	1·43	+0·09
Mean		1·521	

Two measures of this satellite were made on November 4—equatorial and polar. The slight difference doubtless means nothing. All the other measures are *polar*.

Satellite IV.

1894.	Apparent Diam.	At Δ 5.20.	Deviation from Mean.
Oct. 21	1″·58	1″·41	+0″·02
28	1·58	1·38	+0·05
29	1·58	1·38	+0·05
Nov. 4	1·62	1·39	+0·04
5	1·85	1·58	−0·15
11	1·73	1·46	−0·0
12	1·69	1·42	+0·01
18	1·66	1·38	+0·05
19	1·77	1·47	−0·04
Mean		1·430	

All the measures are *polar*.

Results.

We have therefore for the dimensions of these four satellites from the measures with the 36-inch, at distance 5.20—

Satellite I.	1″·048	± 0″·016	(8 nights)
„ II.	0·874	± 0·022	(8 nights)
„ III.	1·521	± 0·023	(10 nights)
„ IV.	1·430	± 0·015	(9 nights)

These correspond to the following values :—

Diameter	I.	2452	± 37 miles
,,	II.	2045	± 51 ,,
,,	III.	3558	± 54 ,,
,,	IV.	3345	± 35 ,,

Early Estimations and Measures of the Diameters of the Satellites.

Numerous early attempts were made to determine the dimensions of these four satellites before telescopes were powerful enough to make proper direct measures of their diameters. A collection of these early efforts is found in the *Vade Mecum* of Houzeau. I shall call on that valuable book for most of the information that follows.

The methods generally employed in these determinations depended upon the known motions of the satellites in connection with the phenomena of eclipse transit occultation, &c.

I shall indicate the method employed by the following initials :—

Entrance into eclipse (E) (this method ought to give too small a value).

Entrance in transit (T).

Entrance in occultation (O).

Measures of the satellite's shadow (S).

This last method I suppose was resorted to because the shadows would be better defined than the satellites' discs.

1693—*Cassini* (E).

I.	II.	III.	IV.
1″·92	1′·97	2′·06	1″·96

This result makes the satellites all essentially of the same dimension, yet his telescope must have shown him that there was really a considerable difference in size.

1734—*Maraldi* (T).

I.	II.	III.	IV.
2″·0	2″·0	2″·2	2″·0

1738—*Whiston* (E).

I.	II.	III.	IV.
1″·98	1″·47	1″·95	1″·64

1771—*Baily* (E).

I.	II.	III.	IV.
1″·9	1′·54	1″·85	...

1788—*Lalande* (E).

I.	II.	III.	IV.
..	...	...	1′·40

1797—*William Herschel* (T and S).

I.	II.	III.	IV.
...	0″·9 (T)	1″·6 (S)	...

1798—*Lalande* (O and T).

I.	II.	III.	IV.
...	...	...	1″·4

1798—*Schroeter* (T).

I.	II.	III.	IV.
1″·16	0″·95	1″·75	1″·18

By combining his measures with those of Harding

I.	II.	III.	IV.
1″·063	0″·870	1″·543	1″·074

by direct measures he got

I.	II.	III.	IV.
1″·15	0″·80	1″·87	1″·17

by measures of the shadows of the satellites on the planet (S)

I.	II.	III.	IV.
...	0″·83	1″·488	1″·273

I have taken the means of these various attempts of this astronomer. They are—

I.	II.	III.	IV.
1″·124	0″·862	1″·663	1″·174

These results of Schroeter are by far the most successful of the early attempts. They are accordant throughout, and differ in minute quantities only from the best determinations made with the most powerful telescopes of to-day. It is certainly a remarkable and highly creditable work for the industrious and accurate astronomer of Lilienthal.

Later Measures of the Diameters.

From this time on the measures were made with telescopes sufficiently powerful to give reliable results, and I shall collect them in tabular form, and have added my own to them.

Filar Micrometer and other Measures of the Diameters of Jupiter's Satellites.
By Different Observers.

Date.	Observer.	I.	II.	III.	IV.
		″	″	″	″
1829	F. Struve	1·015	0·911	1·488	1·273
1856	Secchi	0·985	1·054	1·609	1·496
1863	Mädler	1·200	1·132	1·519	1·300
1871	Engelmann	1·081	0·910	1·537	1 282
1880	Hough	1·114	0·980	1·778	1·457
1891	Burnham	1·112	1·002	1·783	1·609
1894	Barnard	1·048	0·874	1·521	1·430
		Photometric.			
1879	Pickering	0·924	0·866	1·096	0·651
		Interference.			
1891	Michelson	1·02	0·94	1·37	1·31

Engelmann's results are a combination of micrometer measures and observations of the duration of passing the limb of *Jupiter* at transit.

Mr. Burnham's measures were made (with the 36-inch) on one night only, for Professor Michelson, in 1891.

The measures of Michelson were made in 1891, by his method of interference, with the 12-inch equatorial of the Lick Observatory.

Taking the means of these nine sets of measures by nine different observers, omitting Pickering's result for Satellite IV., we have for the diameters of

I.	II.	III.	IV.
1″·055	0″·963	1″·522	1″·395

with which my observations are in good accordance, and from which they differ by

I.	II.	III.	IV.
+0″·007	+0″·089	+0″·001	−0″·035

These measures, made by the same observer with the same instrument and magnifying power, ought to lead to entire confidence in the results of my measures of the diameters of the minor planets, *Ceres*, *Pallas*, and *Vesta* (see *M.N.*, Vol. LIV. No. 9).

The White Equatorial Belt on the First Satellite.

The existence of the white equatorial belt and dark poles of Satellite I. has been amply verified at every favourable opportunity. They are beyond question permanent features of the

satellite, and will always be visible when a favourable transit occurs. At present the transits of I. are projected on the dark reddish south equatorial belt. This condition brings the white belt on the satellite into striking prominence, at the same time that it makes it rather hard to see the dark polar caps. But when the air is steady, with the 36-inch the entire satellite can be seen projected on the dark background. The phenomenon is then very beautiful. The white belt appears like a thin strip $0''.1$ or $0''.2$ broad, and the polar regions are very dark—almost black. Without close attention the satellite then simply looks like a thin white strip $1''$ long by $0''.1$ or $0''.2$ broad. But careful inspection, with sufficient power, will show the entire satellite—white belt, dark poles and all. The belt is then seen to cut distinctly across the middle of the satellite.

In all the late observations of this satellite the belt seems to be exactly parallel to the belts of *Jupiter*, though at some of the former observations it has appeared inclined a couple of degrees from the Jovian equator.

I have previously called attention to the phenomena of the transits of this moon. When it first enters in transit, it is seen as a small round white spot, sharply contrasted with the dusky edge of *Jupiter*. As it enters further and the contrast is less, it becomes slightly elliptical in the direction of *Jupiter's* equator. As it progresses further, this ellipticity becomes rapidly greater. Presently a moment comes when the dark poles equal the brightness of the background, and they disappear ; the white belt is then alone visible, and the satellite appears as a thin white strip. If the transit should carry it across a bright part of *Jupiter's* surface, the phenomenon of duplicity appears. The white belt is lost in the brightness of the background, and the dark poles appear as two dark spots—entirely separate—making the satellite appear double in a line perpendicular to the equator of *Jupiter*. If, however, in transit, it should be projected on a dark part of the planet, the dark poles in general will be lost in the background, and the satellite will appear very much elongated parallel to *Jupiter's* equator, the white belt alone being seen.

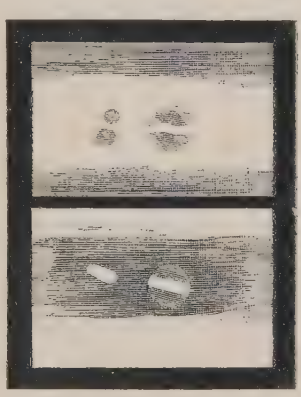
I have looked carefully for any elongation of this satellite when on the sky. Several times I have thought it elongated towards *Jupiter*, but a careful inspection has never convinced me that the elongation was real. With not the best seeing, this appearance of elongation was more decided. Where a casual inspection would seem to show elongation—or polar flattening—a closer inspection would dispel the appearance.

In speaking of his observations of the form of the disc of this satellite with the 36-inch, in a paper dated 1894 June 9 in *Astronomical Journal*, No. 321, vol. xiv., Professor Schaeberle says that to him the disc of I. "appears round only when it is very near to or projected on the disc of *Jupiter*, and elongated in the direction of the planet's equator in all other positions."

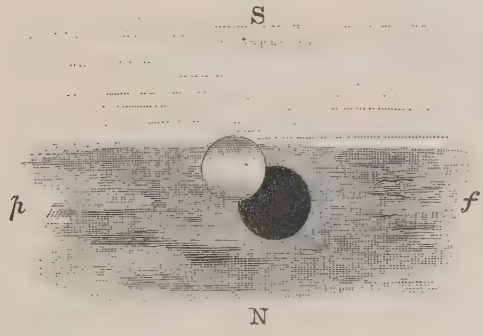
If this were due to a true polar flattening it would suggest a

very rapid rotation of this satellite and not one coincident with its period of revolution. For thus to be seen elongated in essentially all parts of its orbit it must be more or less lens-shaped and not egg-shaped, with the smaller end towards *Jupiter*, or it could not be seen elongated in all parts of its orbit.

Double transit of Satellite I., 1890 September 8.



Satellite I., 1890 September 8 and 1891 August 3, and explanation of the phenomena.



Transit of Satellite I. and its shadow, 1893 November 19; showing the phenomena of bright equatorial belt and dark poles.

Professor Schaeberle has also seen it elongated in transit, for we both watched it one night this winter with the 36-inch, when it appeared as a thin white strip about one second long and about two-tenths second broad projected on the south reddish equatorial belt and parallel with *Jupiter's* equator. At that time, during moments of best seeing, the entire satellite was visible, the poles were very dark—almost black.

I think there is no sort of question but this appearance of elongation on the sky is simply a natural result of the bright equatorial belt and dark polar caps. The satellite actually does become conspicuously elongated when in transit, but no one then watching it would attribute the appearance to a real polar flattening. Now, on the sky this must have a more or less similar effect, through the darkness of the poles and the brightness of its equator. A lack of contrast with the sky in one direction and a good deal of contrast in another, aided by irradiation, and the satellite might well appear elongated towards the planet. This appearance of elongation would doubtless be augmented by indifferent seeing.

I think, therefore, that the dark poles and bright equatorial belt of the first satellite of *Jupiter* thoroughly account for all the phenomena previously reported of the distortion or ellipticity of its disc. This explanation is commended for its simplicity, as it requires no violation of the laws of Nature to satisfy the observation.

It is well here to again make a statement in reference to the discovery of the caps and belt of this satellite. These were discovered by the writer with the 12-inch equatorial of the Lick Observatory, 1890 September 8.

For the facts in connection with this discovery see *A.N.* 2995, p. 318; *A.N.* 3051; *A.N.* 3206, p. 229; *M.N.* vol. li. p. 557, where a drawing is given showing all the phenomena; *M.N.* vol. lii. pp. 14–15; *M.N.* vol. liv. p. 134, where another drawing is given showing the satellite in transit partly occulting its own shadow.

I do not wish it understood that the belt is sharply outlined. It rapidly fades out as it recedes from the equator, but does not terminate abruptly. Or, in other words, the dark polar caps are darkest *at the poles* and become rapidly less intense towards the equator.

I have previously called attention to the fact that this satellite must rotate on an axis almost perpendicular to the plane of its orbit.

I think that the phenomenon of the dark poles of this satellite would rather suggest that its physical condition is not very different from that of *Jupiter*, for the polar regions of *Jupiter* are dark, and so are those of *Saturn*. The density of the satellite is about the same as that of *Jupiter*—another strong proof of actual physical resemblance.

Mount Hamilton, California:
1894 *December* 27.

Observations of the Phenomena of Jupiter's Satellites, and of the Transits of the Red Spot, Dark and Bright Spots, &c., at Bermerside Observatory, Halifax, during the Winter of 1894–1895. By Joseph Gledhill.

Day of Obs.	Satellite.	Phenomenon.	Phase.	G.M.T. of Observation.	*N. Almanac* Time.
1894.				h m s	h m s
Nov. 11	(*a*) I.	Ec. D.	Fading	10 4 0	10 8 10
			Half gone (?)	10 5 0	
			Just gone	10 8 40	
14	(*b*) III.	Sh. I.	Internal contact	11 19 30	11 17 0
15	(*c*) II.	Ec. D.	Fading	9 34 7	9 35 21
			Bisection	9 35 34	
			Just gone	9 37 33	
17	(*d*) II.	Tr. E.	Internal contact	7 55 0	7 59 0
			Bisection	7 57 0	
			External contact	8 0 0	
Dec. 1	(*e*) II.	Tr. I.	External contact	9 56 30	9 57 0
			Bisection	9 58 10	
			Internal contact	10 0 0	
	II.	Sh. E.	Internal contact	11 28 0	11 29 0
			Bisection	11 29 30	
19	(*f*) II.	Tr. E.	Internal contact	6 6 0	6 10 0
			External contact	6 11 0	
	I.	Sh. I.	Internal contact	11 28 0	11 25 0
	I.	Tr. I.	External contact	11 30 0	11 30 0
			Internal contact	11 33 0	
20	(*g*) III.	Sh. I.	Internal contact	7 12 0	7 11 0
	(*h*) III.	Tr. I.	External contact	7 22 0	7 26 0
			Bisection	7 26 0	
			Internal contact	7 30 0	
	III.	Tr. E.	Bisection	10 10 0	10 14 0
	I.	Oc. R.	Bisection	10 51 0	10 53 0
			External contact	10 53 0	
	(*i*) I.	Ec. D.	Fading	8 33 30	8 36 2
			Bisection	8 35 0	
			Just gone	8 36 32	
27	(*j*) I.	Oc. D.	External contact	10 20 0	10 21 0
			Bisection	10 22 0	
			Just gone	10 23 20	

Day of Obs.	Satellite.	Phenomenon.	Phase.	G.M.T. of Observation. h m s	*N. Almanac* Time. h m s
1894. Dec. 27	III.	Tr. I.	External contact	10 37 30	10 41 0
			Bisection	10 42 0	
			Internal contact	10 45 0	
	III.	Sh. I.	Internal contact	11 10 0	11 11 0
	I.	Ec. R.	First seen	12 42 42	12 42 43
			Bisection (?)	12 43 50	
			Full (?)	12 45 20	
29	I.	Ec. R.	First seen	7 11 14	7 11 24
			Bisection	7 12 0	
			Full	7 14 0	
1895. Jan. 2	(*k*) II.	Tr. I.	External contact	8 3 0	8 4 0
			Bisection	8 5 0	
			Internal contact	8 7 0	
	(*l*) II.	Sh. I.	Internal contact	8 38 0	8 37 0
4	(*m*) II.	Ec. R.	First seen	6 12 44	6 13 18
			Bisection	6 14 0	
			Full	6 16 0	
	I.	Tr. I.	External contact	9 20 0	9 23 0
			Bisection	9 22 0	
			Internal contact	9 23 30	
	(*n*) I.	Sh. I.	Internal contact	9 41 30	9 43 0
	I.	Tr. E.	Internal contact	11 42 0	11 39 0
			External contact	11 45 0	
5	(*o*) I.	Oc. D.	Last seen	6 32 0	6 31 0
	(*p*) I.	Ec. R.	First seen	9 5 15	9 6 22
21	(*q*) I.	Ec. R.	First seen	7 25 12	7 25 36
			Bisection	7 27 0	
			Full	7 29 0	
	III.	Oc. D.	External contact	10 0 0	10 5 0
			Bisection	10 3 30	
			Just gone	10 7 45	
25	(*r*) III.	Sh. E.	Internal contact	6 0 0	6 5 0
			Bisection	6 2 0	
	II.	Oc. D.	External contact	9 48 30	9 49 0
			Bisection	9 50 30	
			Just gone	9 53 0	
28	(*s*) I.	Oc. D.	External contact	6 15 30	6 15 0
			Just gone	6 18 0	

Day of Obs.	Satellite.	Phenomenon.	Phase.	G.M.T. of Observation.	*N. Almanac* Time.
1895.				h m s	h m s
Jan. 28	I.	Ec. R.	First seen	9 20 45	9 21 0
			Bisection	9 23 0	
			Full	9 25 0	
Feb. 4	I.	Oc. D.	External contact	8 1 0	8 3 0
			Bisection	8 2 30	
			Just gone	8 4 30	
8	(*t*) III.	Tr. I.	External contact	7 1 0	7 0 0
			Bisection	7 3 0	
			Internal contact	7 6 0	
	III.	Tr. E.	External contact	9 51 0	9 51 0
	III.	Sh. I.	Internal contact	11 10 0	11 8 0
11	(*u*) IV.	Sh. E.	Internal contact	5 58 0	6 8 0
	(*v*) I.	Oc. D.	External contact	9 50 30	9 52 0
			Bisection	9 52 0	
			Just gone	9 55 20	
12	(*w*) I.	Tr. I.	External contact	7 9 30	7 8 0
			Bisection	7 12 0	
			Internal contact	7 13 30	
	I.	Sh. I.	Internal contact	8 15 0	8 14 0
	II.	Ec. R.	First seen	8 26 28	8 27 44
			Bisection	8 28 0	
			Full	8 31 0	
	I.	Tr. E.	Internal contact	9 22 0	9 25 0
			Bisection	9 24 0	
			External contact	9 26 30	
	(*x*) I.	Sh. E.	External contact	10 27 0	10 31 0
			Bisection	10 29 0	
13	(*y*) I.	Ec. R.	First seen	7 40 54	7 40 56
			Bisection	7 42 30	
			Full	7 46 0	
20	(*z*) I.	Oc. D.	External contact	6 9 10	6 11 0
			Bisection	6 11 0	
			Just gone	6 12 20	
	(1) I.	Ec. R.	First seen	9 36 20	9 36 36
			Bisection	9 38 0	
			Full	9 42 0	
21	II.	Sh. E.	Internal contact	5 35 0	5 40 0
			Bisection	5 37 0	

Day of Obs.	Satellite.	Phenomenon.	Phase.	G.M.T. of Observation.	*N. Almanac* Time.
1895.				h m s	h m s
Feb. 21	I.	Tr. E.	Internal contact	5 39 0	5 43 0
			Bisection	5 41 30	
			External contact	5 42 40	
	(2) I.	Sh. E.	Internal contact	6 52 0	6 55 0
26	(3) II.	Oc. D.	External contact	8 34 40	8 36 0
			Bisection	8 37 0	
			Just gone	8 38 50	
	III.	Ec. D.	Fading	8 57 0	9 4 7
			Bisection	8 59 40	
			Just gone	9 5 21	
	I.	Tr. I.	External contact	10 51 7	10 50 0
			Bisection	10 52 40	
			Internal contact	10 54 20	
	(4) III.	Ec. R.	First seen	11 54 23	11 56 34
			Bisection	11 57 0	
			Full	11 59 0	
Mar. 1	(5) I.	Ec. R.	First seen	6 1 7	6 1 18
			Bisection	6 3 0	
			Full	6 5 30	
5	III.	Oc. D.	External contact	7 49 20	7 53 0
			Bisection	7 53 0	
			Just gone	7 55 50	
7	I.	Tr. E.	Internal contact	9 24 20	9 27 0
			Bisection	9 26 0	
			External contact	9 27 50	
16	(6) II.	Ec. R.	First seen	8 6 9	8 7 6
			Bisection	8 8 0	
			Full	8 10 30	
	(7) III.	Sh. E.	Internal contact	10 9 0	10 12 0
21	(8) II.	Tr. I.	External contact	10 54 0	10 59 0
			Bisection	10 56 0	
			Internal contact	10 58 0	
	(9) I.	Tr. I.	External contact	11 2 0	10 59 0
			Bisection	11 2 30	
			Internal contact	11 5 0	
April 7	I.	Ec. R.	First seen	10 8 38	10 8 50
			Bisection	10 10 0	
			Full	10 12 0	

Day of Obs.	Satellite.	Phenomenon.	Phase.	G.M.T. of Observation.	*N. Almanac* Time.
1895.				h m s	h m s
April 10	(10) IV.	Oc. D.	External contact	7 52 0	7 55 0
			Bisection	7 56 to 8[h]	
			Just gone	8 5 0	
	III.	Ec. D.	Fading	9 3 0	9 6 51
			Bisection	9 6 0	
			Just gone	9 8 8	
	(11) IV.	Oc. R.	Bisection	9 45 0	9 48 0
			External contact	9 48 0	
14	(12) I.	Oc. D.	External contact	8 36 30	8 37 0
			Bisection	8 38 0	
			Just gone	8 39 50	
15	(13) I.	Tr. E.	External contact	8 5[m] to 6[m]	8 6 0
	II.	Tr. I.	External contact	8 21 0	8 25 0
			Internal contact	8 24 0	
May 8	I.	Tr. E.	Internal contact	8 28 30	8 34 0
			External contact	8 33 0	

Notes.

(*a*) Violent motion. (*b*) Much boiling; shadow not seen till nearly quite on disc. (*c*) Poor definition; high wind; some cloud. (*d*) Planet low. Bad definition. (*e*) Bad definition. (*f*) Planet low. Poor definition. (*g*) Planet low; much motion. (*h*) A difficult observation, the satellite being not far from the South pole of *Jupiter*. The satellite became invisible before 7[h] 40[m]. (*i*) Satellite entered shadow very close to planet. (*j*) Fair definition to-night. (*k*) Often clouded; much motion. (*l*) Much cloud passing. Satellite invisible at 8[h] 20[m]. (*m*) Violent motion. (*n*) Much motion. (*o*) Much cloud. (*p*) Definition bad. (*q*) Wind; showers of snow. (*r*) Bad definition. (*s*) Much cloud; hazy. (*t*) Definition not good; misty. (*u*) Good definition. A difficult observation owing to shadow being near South pole of *Jupiter*. (*v*) Definition bad. (*w*) Good definition. Satellite I., in transit, became invisible at about 8[h]; not seen again till 9[h] 15[m]. (*x*) Much motion. (*y*) Very misty. (*z*) Good definition. Very misty. (1) Cloudy. (2) Definition not good. (3) Poor definition. (4) Very bad definition. (5) In early twilight. (6) Bad definition. (7) Much motion. (8) Planet low in W. Poor definition. (9) Bad sky. (10) Much boiling. (11) Bad definition. (12) Bad definition. (13) Violent motion.

Some Transits of Dark Spots on the Dark Belt below (N) Jupiter's Equator.

1. A dark spot which passed about $3\frac{1}{2}$[h] before the zero meridian.

Observations.—1894 Nov. 15: 3[h] 21[m] before the zero meridian. Nov. 17: 3[h] 22[m]. Dec. 18: 3[h] 26[m]. 1895 Jan. 2: 3[h] 29[m]; much motion. Jan. 26: 3[h] 30[m]; good. Jan. 21: 3[h] 34[m]; very

bad definition. Feb. 7 : $3^h\ 32^m$; poor definition. Feb. 12 : $3^h\ 35^m$; good definition.

2. A dark spot which passed about $2^h\ 36^m$ before the zero meridian.

Observations.—1895 Feb. 12 : $2^h\ 35^m$; good. Feb. 26 : $2^h\ 38^m$; poor.

3. A dark spot which passed about $1^h\ 8^m$ after the zero meridian.

Observations.—1895 Feb. 8 : $1^h\ 14^m$; fair. Feb. 11 : $1^h\ 15^m$; good. Feb. 13 : $1^h\ 10^m$; fair. Feb. 20 : $1^h\ 9^m$; good. March 11 : $1^h\ 7^m$; bad sky. March 16 : $1^h\ 6^m$; bad sky.

4. A dark spot which passed about $1^h\ 46^m$ after the zero meridian.

Observations.—1894 Dec. 22 : $1^h\ 52^m$; fair definition. Dec. 27 : $1^h\ 45^m$; fair. 1895 Jan. 8 : $1^h\ 47^m$; much motion.

5. A dark spot which passed about $2^h\ 36^m$ after the zero meridian.

Observations.—1895 : Feb. 11 : $2^h\ 35^m$ good. Feb. 13 : $2^h\ 33^m$; fair. Feb. 16 : $2^h\ 34^m$; poor. Feb. 21 : $2^h\ 38^m$ fair.

6. A dark spot which passed about $3^h\ 47^m$ after the zero meridian.

Observations.—1895 Jan. 23 : $3^h\ 51^m$; fair. Jan. 25 : $3^h\ 52^m$; bad. Feb. 4 : $3^h\ 49^m$; fair. Feb. 16 : $3^h\ 41^m$; bad. Feb. 21 : $3^h\ 47^m$; fair. March 7 : $3^h\ 41^m$; fair.

Some Transits of Bright Spots on the same Dark Belt.

1. 1895 Feb. 12 : $1^h\ 39^m$ before the zero meridian.

2. 1895 Jan. 26 : $1^h\ 27^m$ before the zero meridian.

3. 1895 Jan. 24 : $2^h\ 12^m$ before the zero meridian. Jan. 26 : $2^h\ 9^m$. Feb. 12 : $2^h\ 11^m$.

4. 1895 Feb. 7 : $4^h\ 15^m$ before the zero meridian.

5. 1894 Dec. 22 : $1^h\ 7^m$ after it. Dec. 27 : $1^h\ 0^m$.

6. 1895 Jan. 23 : $3^h\ 36^m$ after it. Jan. 30 : $3^h\ 32^m$. Feb. 4 : $3^h\ 32^m$. Feb. 11 : $3^h\ 28^m$. Feb. 16 : $3^h\ 29^m$. Feb. 21 : $3^h\ 32^m$.

Dark Spots on the Dark Belt above (S) the Equator.

1895 Feb. 21 : $2^h\ 39^m$ after the zero meridian. And April 10 : $4^h\ 48^m$ before it.

Transits of the Highest Point of the Slanting Belt close behind the following end of the Red Spot.

1895 Feb. 13 : $0^h\ 36^m$ after the zero meridian. Feb. 20 : $0^h\ 34^m$. March 11 : $0^h\ 40^m$. April 9 : $0^h\ 37^m$.

Transits of Mouths of Bright Sinuous Canals in South Equatorial Band (dark).

1895 Feb. 8 : $3^h\ 7^m$ after the zero meridian. Feb. 21 : $2^h\ 25^m$ after the zero meridian.

The zero meridian used is Marth's II.

The bright spots were on the lower (N) edge of the dark belt.

Transits of the Red Spot.

	Transit of Red Spot.	Transit of Zero Meridian.	Interval.	
1894.	h m	h m	m	
Dec. 12	9 52	9 45	7	Hazy sky.
19	10 37	10 29	8	Spot very faint.
1895.				
Jan. 25	6 2	5 59	3	„ „ „
Feb. 7	11 47	11 41	6	Misty.
8	7 39	7 33	6	Spot faint.
12	10 53	10 50	3	Bad definition.
20	7 32	7 28	4	Good definition.
Mar. 11	8 17	8 13	4	Bad sky.
16	7 28	7 23	5	„ „
Apr. 9	7 25	7 19	6	Much motion.

Dark Transit of Satellite III.

1895 Feb. 8 : Satellite III. passed on to the disc at about $7^h\ 3^m$. It was invisible at $7^h\ 30^m$. At 8^h and until about half an hour before egress ($9^h\ 51^m$) it was seen as a dark (not black) circular spot.

In all the preceding observations Greenwich Mean Time was used ; and the instrument used was the $9\frac{1}{3}$-inch Cooke Equatorial Refractor : powers 240, 330, and 470.

Note on the Red Spot.—Between 1894 November and 1895 March this object was carefully examined whenever visible. It was never seen with ease and distinctness—was always somewhat difficult. No colour was seen in it ; in fact, it was simply an elliptical outline. The best views of it were usually obtained before and after it had passed the central meridian.

The transits were made by placing one web of the micrometer on one limb of *Jupiter*, the other web bisecting the disc.

Photograph of the Nebula near 15 Monocerotis.

By Isaac Roberts, D.Sc., F.R.S.

The photograph of the nebula near 15 *Monocerotis*, R.A. $6^h\ 35^m$, Decl. 10° 0′ north, was taken with the 20-inch reflector on 1895 February 13, with exposure of the plate during three hours, and the copy now presented is enlarged to the scale of 1 millimètre to 24 seconds of arc.

References to the star and to the region around it will be found in the *New General Catalogue*, No. 2264; *The General Catalogue*, No. 1440; Sir J. Herschel's *Catalogue of Nebulæ and Clusters of Stars*, No. 401; Lord Rosse's *Observations of Nebulæ and Clusters of Stars*, p. 53; and Professor Barnard in *Astronomy and Astro-Physics*, vol. xiii. pp. 178, 182.

Sir J. Herschel and Lord Rosse suspected 15 *Monocerotis* to be a nebulous star, or else involved in nebulosity, but they could not detect any nebulosity in the region surrounding the star. Professor Barnard took three photographs of this region in 1894 January and February, and upon them found "nebulosity covering a diameter of about three degrees," and he states that "at 12 minutes of arc *south preceding* 15 *Monocerotis* the nebulosity becomes a compact mass with numerous wisps and holes in it, and the whole group of three or four bright stars is involved in this denser wispy light, but 15 *Monocerotis* itself does not seem to be specially connected with the nebulosity further than to be apparently in it—that is, there are no indications of condensation about the brightest star of the group."

The photograph now presented, and the lantern slide which is projected on the screen, show a multiple star at position angle 219° and distance 8′ 8″ from 15 *Monocerotis*, and this is about the centre of the large condensation of the nebulosity. At position angle 173° and distance 29′ 52″ from 15 *Monocerotis* is the apex of a conical dark space bounded by a rim of nebulosity, and at the apex also are three stars, one about 14th, another about 15th, and the other about 17th magnitude. The space between these and the multiple star is faintly nebulous, and there is also a faint detached curve of nebulosity at position angle 8° and distance 19′ from 15 *Monocerotis*.

Professor Barnard has sent to the Society a positive copy on glass of his photograph of the region surrounding 15 *Monocerotis*, and a lantern slide has been made from it to the scale of the photograph which I have just exhibited. It is now projected on the screen, and you will at once recognise the vast difference between a photograph taken with a small camera and one taken of the same region with a comparatively large reflector. The reflector photograph shows clearly the fine details of the nebulosity and their relationship with the involved and surrounding stars, and also that the stars are far more numerous on

the reflector than they are on coincident areas on the camera photograph. The photo-discs of the stars on the camera photograph are largely out of proportion with the corresponding discs on the reflector photograph, and these large discs cover often several of the near stars which the larger instrument resolves into their separate components. There are vast areas on the camera photograph which to most of us would be accepted as evidence of nebulosity with dark tortuous rifts in it, but it is not nebulosity at all. It is in fact the effect of the diffused light of numerous and close stars being concentrated upon the photo-film by a small instrument, and the dark rifts are only areas with fewer stars on them ; hence they aid in deceiving the eye, by causing the appearance that the crowded star areas are involved in true nebulosity. The lantern slide made from Professor Barnard's plate and now projected on the screen will serve as an illustration of these statements.

Photograph of the Crab Nebula M. 1 Tauri.
By Isaac Roberts, D.Sc., F.R.S.

The photograph of the nebula *M.* 1 *Tauri*, R.A. $5^h\ 28^m$, Decl. $21^\circ\ 57'$ north, was taken with the 20-inch reflector on 1895 January 25, with exposure of the plate during one hour, and the copy now presented is enlarged to the scale of 1 millimètre to 6 seconds of arc.

Two enlarged photographs of this nebula, with an exposure of three hours, were presented to the Society in 1892 May (*Monthly Notices*, vol. lii. p. 502), and this one, with an exposure of sixty minutes, shows less densely the extensions of the nebulosity which are shown on those of 1892 ; and the mottling, and star-like condensations within the denser parts of the nebula, are better seen on this photograph.

All the stars that are shown on the photograph of 1892 are also visible on this, and there is no obvious change in position angles or in brightness of the stars, or in the nebulosity, during the interval of three years between their respective dates.

Dark curved rifts are on the negative conspicuously visible in the dense parts of the nebula, and some of the nebulosity is visible in wispy curves and in condensations more or less star-like. The whole nebula is unsymmetrical in form, and when studied in connection with the descriptions herein given is suggestive of a state of great disturbances internally. One of the dark rifts referred to forms almost a straight line in *nf* and *sp* direction across the centre of the nebula, and has a star of about 15th magnitude at its centre ; another rift forms a triple curve along the north margin of the nebula and extends nearly its whole length from the *south following* end to its *north preceding* end, where it stretches across the nebula to the *south* side.

Notwithstanding the evidence we have of great disturbances

affecting the substance of this nebula, the interval of three years since the first reliable records of its form and internal details were obtained is insufficient to enable me to say that any change has taken place in its structure; but this need cause no surprise, for I have compared a photograph of the great nebula in *Orion* which was taken in 1886 October with another taken in 1894 February, the interval between them being seven years and four months, and although that nebula appears also to be in a state of violent commotion, I have been unable to find that perceptible changes have taken place in the structure of the nebulosity.

Our work, therefore, is to make, preserve, and publish accurate records of the present state of these celestial bodies on a scale sufficiently large to show their structure, and trust that our successors of twenty or thirty years hence will by repetition of our processes obtain data for largely increasing astronomical knowledge.

Note on a Suggested Form of Equatorial Mounting for a (modified) Newtonian Reflector. By Rev. Charles D. P. Davies, M.A.

Attention having been drawn by Dr. Common at the meeting in January to a modified form of Cassegrain reflector, and the general subject of reflectors having been thus brought into prominence, I beg to submit the following ideas, which I have long had in mind, on a modified form of Newtonian equatorial.

First as regards the telescope; second as regards its mounting.

For the form of the telescope I claim no novelty, as I remember seeing it suggested some years ago—I think by Mr. Brashear. It is essentially a modification of the Newtonian. The speculum, both in itself and in its position, is entirely Newtonian. But at the upper end of the tube is an elliptical flat, set at an angle of 45°, having its minor axis equal to the diameter of the speculum; that is to say, it fills up the tube. This flat is the first glass to receive the rays of light, which are admitted by a suitable opening in the side of the tube. The rays reflected at a right angle pass, still parallel to each other, down to the speculum, whence they are returned to a hole in the centre of figure of the flat. Through this hole they pass to the eyepiece.

S speculum, F flat, E eyepiece.

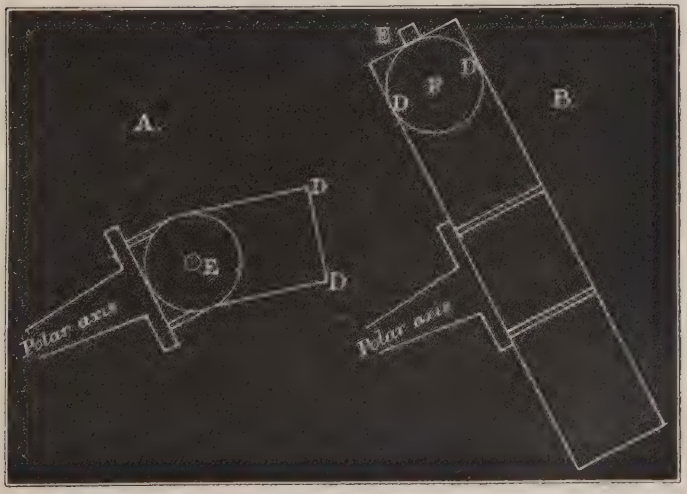
Fig. 1.

Optically the instrument is perfect—at least there is no distortion. There is only the usual number of two mirrors of the usual Newtonian figure.

The observer is well removed from the opening of the tube, so that the interference of heated air from his body is avoided—at least quite as much as it is in the ordinary Newtonian.

But compared with the latter this form has two very distinct advantages. First, there is a complete absence of the troublesome flare and "wings" produced by the steel strips generally employed for the suspension of the ordinary flat; and not only so, but there is also an absence of the defection of light caused by their intervention; and to both of these there is to be added the fact that the hole for the eyepiece, except in small telescopes, would probably not be nearly so large in diameter as the cell of the common flat. Secondly, the occurrence of tarnish. A spot of tarnish of given diameter (say $\frac{1}{2}$ inch) on an ordinary flat (say 2 or 3 inches minor axis) affects an immensely greater proportion of the total light than would be affected by a spot of the same diameter on the larger flat proposed.

I am far from wishing to be blind to any difficulty. The larger flat would of course be more expensive not only owing to its size, but by reason of the necessary drilling of the hole. (Possibly this might be avoided by their being cast ready of the required form.) But this drawback once fairly stated I must confess that at present I can see no other.



(A) In the meridian viewing a circumpolar star at its lower culmination.

(B) Six hours from meridian viewing the rising of an equinoctial star.

Both elevations from the East.

Fig. 2.

As regards fixing the flat much the same lines would naturally be adopted as those in general use for specula. The question of dew might easily be met by any desired prolongation of the circular opening DD made of almost any light material.

I come now to the second but chief point in the present paper. This is the question of the mounting. It appears to me that this form of telescope is eminently suitable for mounting as an equatorial. I would mount it as follows :—I would put the telescope itself in the position generally occupied by the declination axis. That is to say, I would put it across the centre of the upper end of the polar axis, with its axis of collimation at right angles to the polar axis, making it revolve for declination on its axis of collimation. That is to say, the line of collimation of the telescope will be the declination axis.

Among the advantages of this form of mounting it seems to me that we can reckon on the following :

(1) Absence of that most undesirable of all adjuncts, the counterpoise, that terrible mass that doubles the weight to be carried by the two axes, besides taking up much valuable space in the dome.

Appended to this consideration it may also be observed that there is an absence not only of the counterpoise, but of the declination axis itself with still further consequent lightening of the weight to be borne by the polar axis.

(2) Increase of stability of the instrument, inasmuch as not only is the telescope firmly held on either side of its centre of gravity by the brackets attached to the upper end of the polar axis ; but carried, as it is, immediately on that axis instead of being held out at arm's length from it, there must be far less liability to flexure, the great enemy of exactitude, and equally less liability to tremor.

(3) With this mounting the telescope is perpetually free for actuation by the clock. No position can be reached in which it must be reversed to the other side of the stand. The telescope may be directed to any star, the clock started, and left to do its work for twenty-four hours if necessary.

(4) Possibility of uniform height of the eyepiece above the observer's standing or sitting level in every position of the telescope. This I would secure by a circular platform or gangway of suitable diameter around the instrument in the plane of the equinoctial. With a little simple adaptation or variation this could be managed even in the proximity of the equator. In our own latitude the platform would consist of steps of moderate gradient, while in the high latitudes it would become little, if anything, more than a gentle slope. An observing chair could be made to suit the steps and gradient of the platform. No screwing up or

down ladders, no hydraulic or other lifting and depressing of floors.

(5) At all times and in all positions of even the largest telescope, every part of it along its whole length from speculum to eyepiece is within reach of the observer or his attendant, without climbing of any sort.

(5a) Attachment of handles for slow motion in R.A. and Dec. would be greatly simplified.

(6) As the rotation of the tube in its cradle would form the setting for declination, it is manifest that any necessity for that process during the progress of a lengthened observation would entirely vanish.

(7) Absolute freedom of view to any part of the celestial vault. The whole heavens would be open to the instrument without any need of reversal from E to W, or *vice versâ*. Here is an advantage over any other non-counterpoised form of mount that I know. Take for instance the "hay-fork" mount. Unless the prongs of the fork are too long for complete stability, there is a certain amount of restriction to the scope of the instrument. And having mentioned the "hay-fork" I may add that when its telescope is at any considerable distance from the meridian there must be a very unfair amount of weight and cross strain on the prong that for the time being is lowest.

(8) Last but not least, a saving in the size of the dome, and therefore in its weight, and in the size and expense of the whole observatory—a saving that might easily more than compensate for the form and larger size of the flat.

Observations of Minor Planets made with the 15-inch Equatorial of the National Mexican Observatory, Tacubaya.

By Felipe Valle.

(*Communicated by the Secretaries.*)

Long. W. $6^h\ 36^m\ 46^s.53$. Lat. N. $19°\ 24'\ 17''.5$.

Date.	Mean Time.	Planet − ✶ Δα.	Planet − ✶ Δδ.	No. of Comps.	Planet App. R.A.	Log (ρ×Δ) of Parallactic Factor.	Planet App. Decl.	Log (ρ×Δ) of Parallactic Factor.	Red. to Day.	No. of Comp. Star.
					(176) *Idunna.*					
1894.	h m s	m s	′ ″		h m s		° ′ ″		s ″	
Oct. 3	11 32 58	+1 41·11	−1 05·85	5, 5	0 20 52·16	7·971+	+10 29 27·9	0·131+	+3·44 +23·90	1
6	10 52 47	−1 17·21	−1 37·58	4, 4	0 19 05·47	8·766*n*	+ 4 47 39·8	0·209+	+3·46 +24·15	2
8	11 20 03	−0 38·34	−0 26·80	6, 6	0 17 54·04	8·522+	+ 9 19 39·9	0·185+	+3·46 +24·15	3
9	10 06 56	−0 58 34	+4 10·40	6, 6	0 17 21·73	9·129*n*	+ 9 02 10·4	0·200+	+3·48 +24·32	4
10	8 53 05	+2 01·00	−3 10·41	5, 5	0 16 49·63	9·465*n*	+ 8 53 32·3	0·251+	+3·47 +24 24	5
11	8 47 29	−1 37·39	−6 22·32	6, 6	0 16 17·13	9·469*n*	+ 8 39 49·8	0·259+	+3·48 +24·35	6
					(90) *Antiope.*					
Oct. 6	10 53 31	−2 12·31	+2 12·06	5, 5	0 51 52·10	9·122*n*	+2 22 16·2	0·412+	+3·55 +24·82	7
9	11 17 36	+3 52·01	−1 11·48	5, 5	0 49 33·30	8·607*n*	+2 09 22·6	0·416+	+3·56 +24·64	8
11	9 47 09	+1 06·36	+0 50·39	7, 7	0 48 05·26	9·363*n*	+2 01 19·2	0·423+	+3·57 +24·58	9
					(87) *Sylvia.*					
Oct. 26	8 48 02	+0 18·96	+1 32·50	5, 5	2 22 24·30	9·256*n*	+3 05 25·0	0·418+	+3·75 +25·23	10
30	9 40 22	−0 17 85	−1 55·36	10, 10	2 19 17·10	9·449*n*	+2 58 55·1	0·405+	+3·79 +25·14	11
31	9 37 02	−1 03·98	−3 18·98	10, 10	2 18 30·97	9·444*n*	+2 57 31·5	0·383+	+3·79 +25·11	12

Comparison Stars.

No. of Comp. Star.	α 1894·0	δ 1894·0	Authority.	Date 1894.	Difference between observed and calculated positions. Obs. Δα.	Calc. Δδ.	Ephem.
	h m s	° ′ ″			s	″	
2	0 20 19·22	+9 48 53·2	B.D. + 9°, 41 (9·0)	...	...	...	...
4	0 18 16·69	+9 02 35·7	B.D. + 8°, 41 (8·7)	...	...	...	...
5	0 14 45·16	+8 56 18·5	B.D. + 8°, 32 (8·9)	...	...	...	...
6	0 17 51·04	+8 45 47·8	B.D. + 8°, 39	...	...	...	...
7	0 54 01·01	+2 19 37·9	Anon. 10·5 Ref. to 500 Yarn.	Oct. 6	−3·59	−14·5	Astr. Jahrbuch
8	0 45 37·51	+2 10 09·12	440 Yarn.	9	−3·23	−14·6	,,
9	0 46 55·33	+2 00 04·2	Anon. 9·7 Ref. to No. 8	11	−3·20	−13·2	,,
10	2 22 01·59	+3 03 27·30	B.D. + 2°, 379 − O.A. Merid. Circ.	26	−0·76	− 2·4	,,
11	2 19 31·16	+3 00 25·3	B.D. + 2°, 370 − Ref. to Nos. 10, 12	30	−0·71	− 3·8	,,
12	2 13 40·13	+3 02 53·2	B.D. + 2°, 358 − O.A. Merid. Circ.	31	−0·75	− 3·8	,,

1	Δα = + 1 m 31·64 s	Δδ = − 3 ′ 50·02 ″	Ref. to B.D. + 10°, 39 (9·3)
3	Δα = + 3 28·83	Δδ = − 0 47·49	Ref. to B.D. + 9°, 30 (8·8)